POWER

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Water Power Policies

SUPPOSE you owned a water power! Not one of those little farm-brook affairs about which so many dreams impossible of realization cluster, but a real project that could be developed but was running to waste.

Suppose you could absorb in your own business all the power that the development of the site would make available.

Would you say: "I cannot trust myself to carry this thing through. I am a manufacturer and not an engineer or a promoter. I should be so likely to be imposed upon. Here! some of you good fellows with money to invest, just take my rights in this thing and develop it for me and sell me the power, me and my descendants even unto the nth generation for what a group of people satisfactory to you shall say it is worth. My folks may want it back after fifty or a hundred years, but we can fix that somehow."?

Or would you hire a man or a group of men whom you could trust and tell them to go ahead and develop the power and sell it on a self-supporting basis to your various industries, issuing bonds against it if you did not have the necessary ready money, but retaining the title, the rights, the regulation of rates and of salaries and service and the unearned increment in your own hands?

That is to say, you might set up a company to develop and administer the project, of which company you would own all the stock.

This is what Governor Smith proposes for New York State to do with its water powers. He would have a Power Authority develop them as the Port Authority is developing the port. Backed by the state's right of eminent domain, each worth-while project could be financed upon its physical resources and earning power with assurance of the return of the principal to the investor with interest for the time of its use, but with no other enhancement, and of power at cost to the consumer.

And if the divorcement from political interference was complete, each project would be developed and managed financially and otherwise by a group of experts just like any other power company, only the state would, by its sole ownership of the stock, keep this increasingly important natural resource in its own hands.

F. R. Low

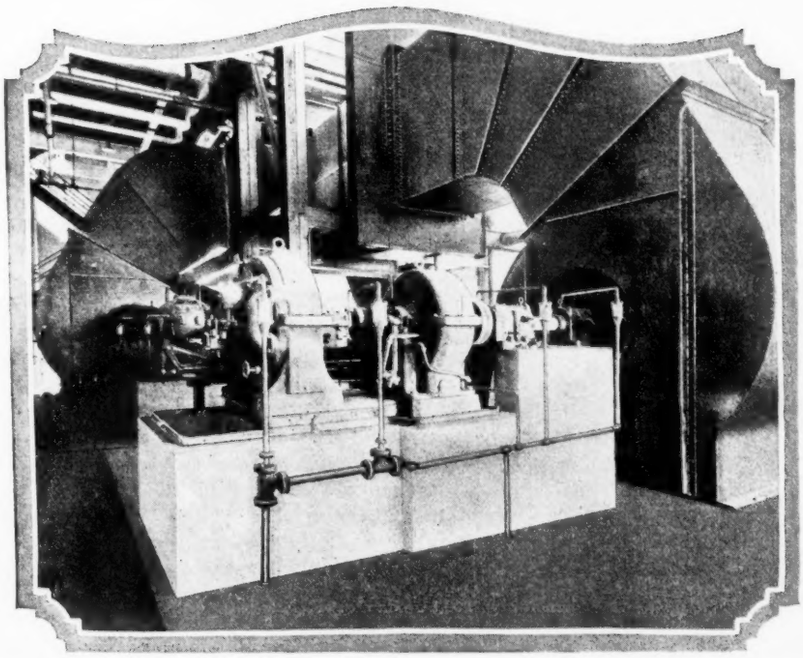
Reliability and Safety Outstanding Features in New Stand-by Plant

Harbor Point Steam Plant of the Utica Gas-& Electric Co., Utica, N. Y., Is Designed for Stand-by Service, but Is so Arranged That Future Extensions May Be Easily Made To Take Care of Any Requirements That May Arise. The Development Has Been Laid Out for 185,000 Kva., with 37,500 Kva. Installed

IT WOULD be difficult to find a section of the country where there are a greater number of uncertain factors in the development of a power system than in central New York. Among these are the political situation with respect to water-power development in the state, the possibilities of developing large blocks of power on the St. Lawrence River and the future power development at Niagara Falls, the interconnection of existing power systems and the proposed superpower system. It is in about the center of this district that the Utica Gas & Electric Company built its new steam plant. About five years ago studies were started on how the future growth of the system could be most economically taken care of. At that time Trenton Falls, a hydro-electric plant of 22,000 kw., three other small hydro plants, and Washington Street steam plant of 20,000 kw. rating in the City of Utica, were in operation. Since that time the capacity of Trenton Falls has been increased to 28,800 kw., by improvement made in the waterwheels, which brought the total capacity of the system to 61,000 kw. A connection has also been made with the Northern New York Utilities System. On account of low-water conditions that were likely to occur, and in order to increase the reliability of power supply to Utica, it was decided that the present extension to the system should be a steam plant in that city.

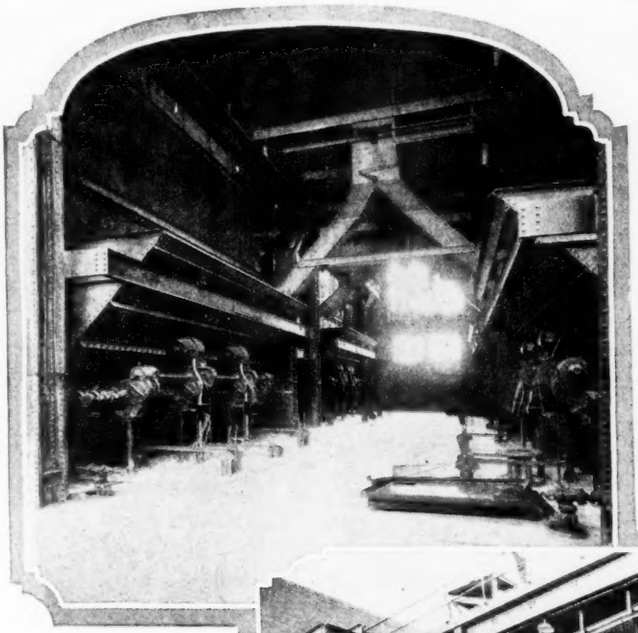
The requirements could be satisfied either by extending Washington Street Station or by building a new plant at another locality. Washington Street Station was first built about 20 years ago, with 5,000-kw. rating and has since been remodeled and its capacity increased to 20,000 kw. This plant, like most others that have grown up over a long period to meet the increasing demands of a power system, is of low economy as compared with modern plants. Possible future developments in power systems in this part of New York State also made it desirable to lay out a plant on a scale that was not possible at the Washington Street location. For this reason it was decided to build a new plant rather than extend the old one. The improvement in economy to be obtained in a new development, over the old plant, would also make it desirable to put all the steam capacity in a new plant and hold the old one for emergency service. As the company's system has also been tied in with a number of others, the old plant's value for stand-by service is materially increased.

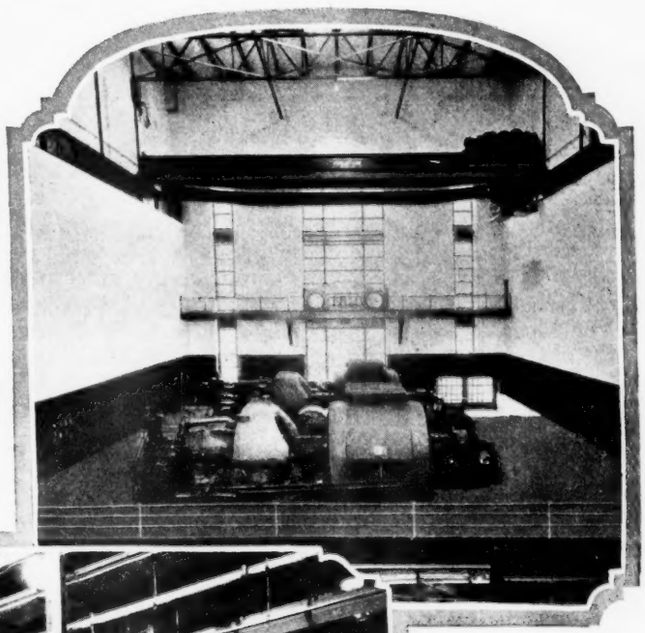
When deciding on the size of the new plant, it would have been a comparatively easy matter to plan a station for the company's system if this was the only considera-

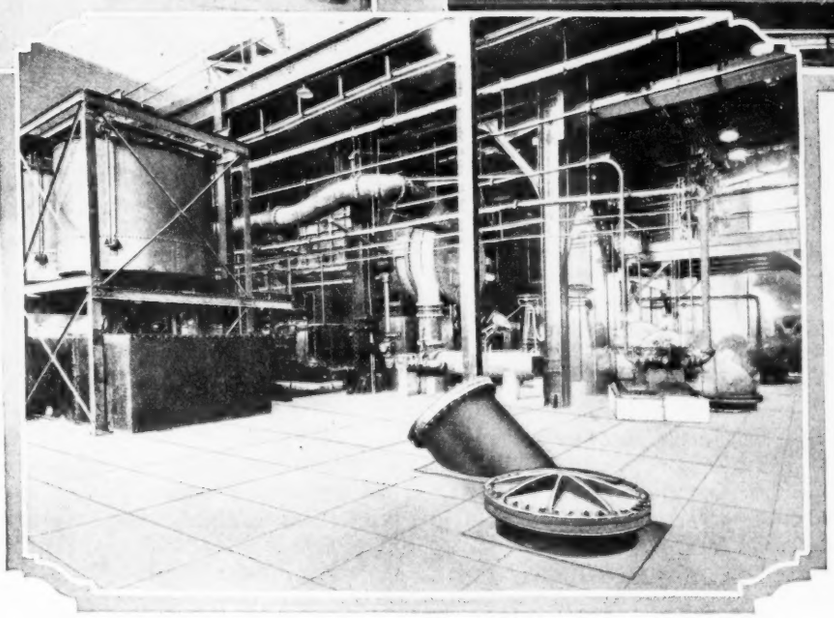


Right—Short stacks with turbine-driven induced-draft fans supply the boiler's draft

Below—Two 18,750-kva. units installed with space for an equal amount of additional capacity





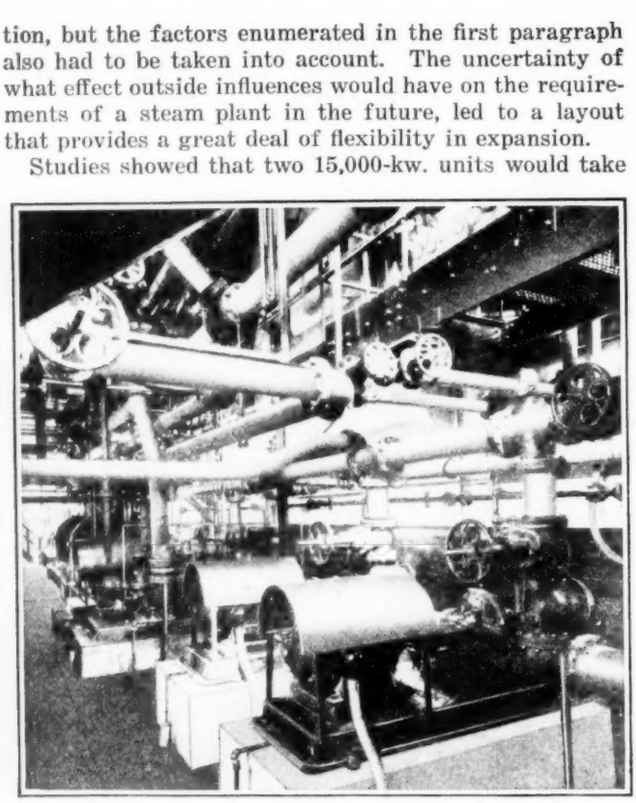


Above—Four stoker-fired boilers supply steam at 290 lb. and 125 deg. F. superheat

Left—Weigh tanks for testing main units located on turbine-room basement floor

tion, but the factors enumerated in the first paragraph also had to be taken into account. The uncertainty of what effect outside influences would have on the requirements of a steam plant in the future, led to a layout that provides a great deal of flexibility in expansion.

Studies showed that two 15,000-kw. units would take



Pumps in turbine-room basement

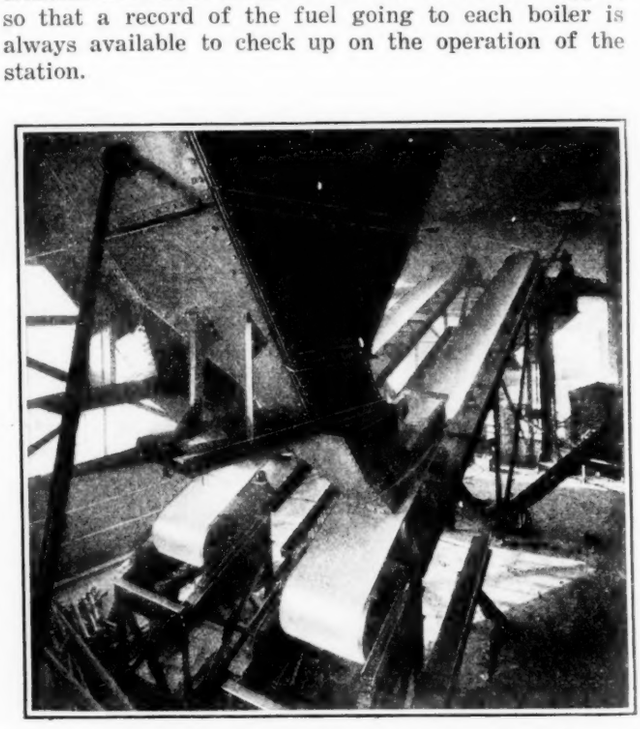
care of the present requirement, but that possible developments might make it desirable to install much larger units in the future. As the turbine room is now built, it is wide enough to install 30,000-kw. machines, and the boiler room has been arranged so that sufficient boiler capacity can be provided. If the third unit is of 30,000-kw. capacity, the two 15,000-kw. machines can be operated in parallel as a 30,000-kw. unit and connect through a single 30,000-kw. bank of step-up transformers to the proposed 110,000-volt transmission system.

The plant has been designed with great consideration given to safety, continuity of service and to the possible changes in the demands in the power load. Among some of the features are duplicate auxiliaries, one unit being turbine driven and the other motor. When deemed essential to the continuous operation of the plant, these auxiliaries have been supplied from duplicate sources. An isolated phase arrangement has been used and the busbars and connecting bars have been taped, although located in separate concrete compartments on separate floors. Cables and insulators designed for 25,000 volts have been used on all 13,200-volt service, and the oil switches have a rupturing capacity of 1,500,000 kilovolt-amperes.

The new plant is at Harbor Point on the Mohawk River, about two miles from the center of Utica. With the present conditions of unregulated flow on this river, low water will limit the capacity of the steam plant to about 90,000 kw. Future storage on the river for water-power development will easily provide sufficient circulating water for 150,000 kw. in a steam station.

Although the plant is near the barge canal, coal is received by rail only, but provisions have been made so that it can be obtained by water if future developments make this desirable. Coal is dumped directly from railway cars into a 600-ton pit at the boiler-room end of the plant. A 50,000-ton coal-storage yard is adjacent to the plant, ready for immediate use with very large additional space for storage. In this yard coal is delivered from cars with a gantry crane and grab bucket and is distributed on the pile with a drag-scraper and tractor. This method of distributing the coal on the pile insures that the fines will be mixed with the larger sizes and that the distribution on the pile will be in layers. The tractor and scraper also pack the coal into a solid mass and prevent the circulation of air. All these factors work toward preventing fires starting in the pile. Coal stored by this method has been in a pile 20 ft. high for 26 months without any indications of developing dangerous temperatures. Reclamation of coal from the pile is done with a locomotive crane and grab bucket which is used for loading railway cars. These cars, as previously mentioned, are emptied directly into the coal pit at the plant.

Coal from the pit is hoisted into the coal tower, from where it passes through the crusher onto a double-apron conveyor and into a hopper. From the hopper weighed distribution is made to the bunker in four-ton cable cars. The coal-handling equipment has a capacity of 200 tons per hour, which is sufficient for any future growth of the plant. A weigh larry distributes the coal from the bunker to the stoker hopper, so that a record of the fuel going to each boiler is always available to check up on the operation of the station.



Belt conveyors deliver coal from crusher to cable cars for distribution in bunker

In the present installation there are four single cross-drum water-tube boilers, each having a normal heating surface of 16,100 sq.ft. These boilers are equipped with fin-tube water walls, and cast-iron water backs are installed in the bridge walls, which add about 500 sq.ft. of effective heating surface to each boiler, besides contributing greatly to reducing the brickwork maintenance. At 250 per cent rating three of the boilers can carry the two turbines at full load and two

boilers, when operating at approximately 375 per cent rating, can take care of full load on the plant.

A pressure of 275 lb. gage and superheat of 125 deg. F. were chosen for the steam conditions at the throttle of the turbine. For stand-by service it was considered that these steam conditions are better suited than the higher pressures and temperatures used in some of the modern plants. They result in a considerable reduction in the investment and they also do not require the highly skilled operating staff that is essential to handling extremely high pressure and temperatures.

Stokers of the underfeed type were selected for firing the boilers. Each stoker is driven by a direct-current motor with another held as a spare. At their maximum rating the stokers will burn 30,800 lb. of coal per hour for eight hours. At 300 per cent rating the guaranteed efficiency is 74 per cent, and at 100 and 200 per cent rating the guaranteed efficiency is 78 per cent.

Ashes from the furnaces pass through clinker grinders into hoppers that provide 22-hour storage at 200 per cent rating of the stokers. From the hoppers the ashes are removed by hydraulic sluicing.

Both forced-draft and induced-draft fans are used. The induced-draft fans are all turbine-driven and discharge into short stacks. On these fans very wide ranges of speed are required for efficient operation. This requirement could be met at a considerably lower initial cost with turbine-driven equipment than with motors. These turbines are equipped with hand-operated valves to adjust the number of nozzles in use so as to maintain a good water rate for the turbine even at slow speeds and light loads.

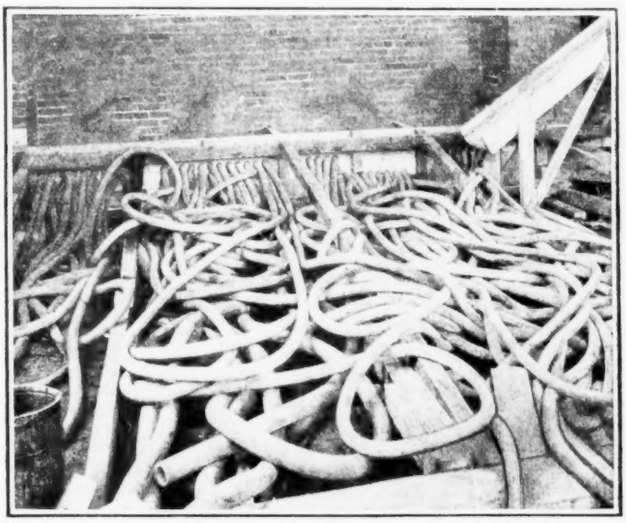
Of the forced-draft fans, two are motor-driven and one turbine-driven. Wound-rotor induction motors are used with controllers that provide for a 50 per cent speed reduction. As all the fans discharge into a common duct, this speed range is sufficient to give economical operation at all loads. The turbine-driven fan provides for any emergency and allows operating the boilers with the main generating units shut down as may be the case when all the load is carried on water-power plants and one boiler is operated to supply steam to a near-by gas plant.

As previously mentioned, in the present installation there are two 15,000-kw. units. These operate at 1,800 r.p.m. and have a guaranteed water rate at their best loading of 11.75 lb. per kw.-hr. with steam at 275-lb. gauge and 125 deg. superheat at the throttle, expanded to a 28.7-in. vacuum. A turbine of a somewhat better water rate at one loading could have been obtained. In this plant operation will include a wide variation in loads, so that a turbine at a fairly good water rate over a large range of load is a more economical unit than one that has a low water rate at one point. On the units selected the water rate remains at approximately 12 lb. per kw.-hr. from 9,000 to 15,000 kw. load.

The surface condensers are bolted rigidly to the turbines and are supported on springs. The water-boxes are divided so that half of the tubes may be taken out of service for cleaning while the condenser is in service. The plant is located on a sharp bend in the river, and circulating water is taken from the upstream side of this bend and discharged on the downstream side.

On account of the poor soil conditions at the plant, it was more advantageous to use cast-iron pipes for the condensing water instead of concrete tunnels. These pipes are supported on piled concrete mats. Two 42-in. suction lines serve each condenser, which take the water in through revolving screens located at the river. The condensers discharge through a reducing manifold to an 84-in pipe line. From the discharge manifold, a 36-in. connection leads to a point above the intake, so that in severe weather part of the discharge of the condensers can be returned to the intake to prevent freezing.

There are two closed feed-water heaters on each unit, one low-pressure and one so-called high-pressure. Steam for heating in the low-pressure heaters is bled from the 29th row of blading of the main turbines. This raises the temperature of the feed water to about 165 deg. F. All the exhaust from the auxiliary turbines goes into the high-pressure heaters, which are also connected through heat-balance valves into the sixteenth row of blading of the turbines. Any deficiency of heating steam is supplied by the main unit to bring the temperature of the feed water up to about 210 deg. F., which is the temperature at which it goes to the boiler. If there is an excess of exhaust steam from the auxiliary turbines the heat-balance valves open automatically and the excess goes to a low stage of the main unit.



Murray duct in the building concrete used for installation of electric conductors

Although provisions are made in the main turbines to bleed at two high-pressure points, high-pressure heaters have not been used, as their cost was not considered justified in this plant. These heaters would have to go in on the pressure side of the feed pumps, which would require that they be designed for a working pressure of about 400 lb. This makes the cost of the heaters run so high that the increased efficiency due to their installation could not be justified in a stand-by plant.

A combination heater and deaërator has been installed in the feed-water system, but this is of comparatively small capacity. Its chief use will be during periods when the turbines are shut down and part of the boiler plant is operated to supply steam to a near-by gas plant. From this process there is no return to the boilers, so that all feed water is makeup which is taken from the city mains and is of a quality that can be used in the boiler without treatment other than deaërating.

The plant has been provided with two 30,000-lb. weighing tanks, each on a scale. The capacity of each tank is about equivalent to the condensate from one

unit at full load for ten minutes. Since the coal is weighed for each boiler in the larry, these tanks provide a means of obtaining a very close check, not only on the turbine's performance, but on the complete unit, including the boilers. While these tests are being made, the flow meters on the unit can also be checked.

In the present installation the two generators are rated at 18,750-kva. three-phase, 60-cycle, 13,800-volt and 80 per cent power factor. At present, the output of the machines is taken at generator voltage a distance of 3,000 ft. to the company's main switching station.

This plant was designed by Thomas E. Murray, Inc., consulting engineers, New York City, in co-operation with the engineers of the Utica Gas & Electric Company.

MECHANICAL EQUIPMENT, HARBOR POINT STATION UTICA GAS & ELECTRIC COMPANY

TURBINE-GENERATORS

Number	2
Manufacturers	Westinghouse Elec. & Mfg. Co.
Steam pressure at throttle, lb. gage	275
Superheat, deg. F	125
Stage bleeding points	4 (2 now in use)
Speed, r.p.m.	1,800
Guaranteed water rate with above steam condition expanding to 28.7 in. vacuum corrected to 30-in. barometer.	
Load in kw. at 80% Power Factor	Water Rate, Pounds
6,000	13.35
9,000	12.25
12,000	11.75
15,000	12.00
Turbine guaranteed to operate at all loads above 1,000 kw. at maximum vacuum.	
Generator, rated capacity, kw. at 80 per cent power factor	15,000
Voltage, 13,800; frequency, 60 cycles; 3-phase	
Direct-connected exciter, 250 volts, 180 kw.	
Emergency exciter, capacity, kw.	200
Maker	General Electric
Driven by Terry steam turbine	
Water rate at 1 lb. gage back pressure and full load 56.5 lb. per kw.-hr.	

SURFACE CONDENSER

Number	2
Manufacturer	C. H. Wheeler Mfg. Co.
Total tube surface, sq.ft.	20,000
Tubes, Muntz metal, size, in.	1 O.D.
Numbes of passes	2
Supports	Spring
Connection to turbine	Rigid
Divided water-box so that one-half of condenser can be cleaned without taking unit out of service	

CIRCULATING PUMPS

Number per condenser	2
Manufacturer	C. H. Wheeler Mfg. Co.
Capacity each, gal. per min.	12,500
Drive	One motor and one turbine
Size motor, hp.	100
Manufacturer of motors	General Electric Co.
Manufacturer of turbines	Terry Steam Turbine Co.

HOTWELL PUMPS

Number per condenser	2
Manufacturer	C. H. Wheeler Mfg. Co.
Capacity, gal. per min.	540
Drive	One motor and one turbine
Size, hp.	30
Manufacturer of motor	General Electric Co.
Manufacturer of turbine	Terry Steam Turbine Co.

STEAM JET AIR PUMPS

Number per condenser	2
Type	Rado-jet
Manufacturer	C. H. Wheeler Mfg. Co.
Rated capacity, at 29-in. vacuum, lb. of free air per hr.	75

BOILERS AND AUXILIARIES

Number of boilers	4
Manufacturer	D. Connelly Boiler Co
Steam-making surface per boiler, sq.ft.	16,100
Water-walls and water-back add about 500 sq.ft. (each boiler)	
Combustion space, cu.ft.	6,850
Maximum steam pressure, lb. gage	290
Manufacturer of superheater	Superheater Co.
Superheater surface per boiler, sq.ft.	3,840
Location of superheater; above top bank of tubes	
Total steam temperature at 200 per cent rating, deg. F	540

BOILERS AND AUXILIARIES (Continued)

Type of water walls	Fin tube
Manufacturer	Combustion Engineering Corp.
Manufacturer of water-backs	Power Specialty Co.
Air-cooled blocks in front and side walls	Furnace Engineering Co.
Boiler settings	Rust Engineering Co.
Firebrick	Harbison Walker
Soot blowers	Marion Machine & Foundry Co.
Blowoff valves	Everlasting Valve Co.
Feed-water regulators	Northern Equipment Co.

STOKERS AND DRAFT EQUIPMENT

Manufacturer of stokers	American Engineering Co.
Drive for each stoker	Two 15-hp. G. E. d.-c. motors
Number of retorts	14
Projected grate area, sq.ft.	377.6
Number of fans	4 induced draft and 3 forced draft
Manufacturer	B. F. Sturtevant Co.
Capacity of induced draft, each	278,000 cu.ft. per min., 4.6 in. static pressure
Capacity of forced draft, each	120,000 cu.ft. per min., 7 in. static pressure
Drive, induced-draft, fans	Steam turbine
Drive, forced-draft fans	Two turbine and one motor
Manufacturer of turbines	Terry Steam Turbine Co.
Manufacturer of motor	General Electric Co.

FEED-WATER PUMPS AND HEATERS

Number feed pumps	3
Manufacturer	Platt Iron Works
Drives	Two turbine and one motor
Manufacturer of turbines	Terry Steam Turbine Co.
Manufacturer of motor	Westinghouse Electric & Mfg. Co.
Capacity of pumps	Two, 750 gal. per min. and one 250 gal. per min.
Number of closed heaters	Two per turbine
Manufacturer	Croll-Reynolds Eng. Co.
Capacity, low-pressure heaters, lb. per hr.	200,000 from 96 to 168 deg. F.
Capacity, high-pressure heaters, lb. per hr.	230,000 from 168 to 205 deg. F.
Capacity comb. heater and deaërator, lb. per hr.	25,000 from 30 to 207 deg. F.
Hotwell storage heaters	Griscom-Russell Co.
Manufacturer of heater and deaërator	Croll-Reynolds Eng. Co.

MISCELLANEOUS EQUIPMENT

Coal-handling equipment	Maine Electric Co.
Fire, house and ash-sluicing pumps	Platt Iron Works
Stacks	American Bridge Co.
Condensate test equipment	R. J. Shields
Hydraulic ash handling	Allen-Sherman-Hoff Co.
Boiler blow off tanks	M. H. Treadwell Co.
Oil purification system	S. F. Bowser & Co.
Oil pumps	Viking Pump Co.
Heating-system vacuum pump	Nash Eng. Co.
Sump pumps	Yeomans Brothers
Air compressor	Chicago Pneumatic Tool Co.
Revolving screens	Link Belt Co.
Gratings for walks	Irving Iron Works
Turbine-room crane	Cleveland Crane & Eng. Co.
Circulating-water cast-iron pipe	U. S. Cast-Iron Pipe & Foundry Co.
Special circulating-water castings	Davies & Thomas
High pressure piping	M. W. Kellogg Co.
Cast-iron and steel pipe fittings	Walworth Co.
Gate valves	Chapman Valve Mfg. Co.
Globe valves	Hancock Inspirator Co.
Automatic non-return valves	Foster Engineering Co.
Atmospheric relief valves	Atwood & Morrill
CO_2 Indicators and recorders	Permutit Co.
Load indicators and master gages	Chas. Cory & Sons.
Venturi meters	Simplex Valve & Meter Co.
Steam-flow meters and draft gages	Bailey Meter Co.
Steam pressure gages	Crosby Steam Gage & Valve Co.
Temperature recorders	Bristol Co.
Barometer and vacuum recorder	Uehling Inst. Co.
Industrial Thermometers	American Schaeffer & Budenberg Corp.
Storage battery	Electric Storage Battery Co.
Transformers, switchboards and switching equipment	Westinghouse Elec. & Mfg. Co.
City water meters	Neptune Meter Co.
Pipe covering	Robert A. Keasby Co.

Improvement in Combustion by the Use of Steam Jets

By C. D. Zimmerman
Test Department, Cleveland Electric Illuminating Co.

STEAM jets have been installed on a group of nine boilers at the Lake Shore Station of The Cleveland Electric Illuminating Company with a marked improvement in combustion. These boilers are some of the oldest in the plant, and although the efficiency was good and the smoke conditions acceptable to the city ordinance, these conditions were not quite so good as shown by the more up-to-date equipment installed in the station.

The usual study of furnace stratification was first made and experiments were then carried out with different combinations of air jets and later with steam jets. These experiments were completed in February,

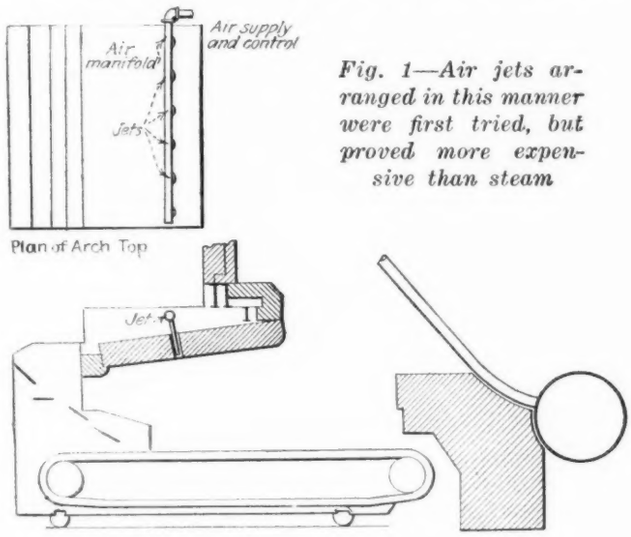


Fig. 1—Air jets arranged in this manner were first tried, but proved more expensive than steam

and the final system adopted at that time has been in use since then.

With the idea of eliminating the stratification of the gases in the furnace, air jets were first tried as shown in Fig. 1. These jets were installed through holes in the top of the arch and compressed air forced through them to blow the gases away from the surface of the arch and cause them to mix with the air before leaving the furnace. This method proved successful, but was found to be more expensive than using steam in the manner hereinafter described.

These experiments, made with steam jets located at different points, indicated that the improvement was a function of the turbulence caused by the jets rather than by the mixing of the gases with the air sent in by air jets. Consequently, a thorough study was made of the effect of varying the number and position of the steam jets. The results of these experiments showed that two jets located near the front of the furnace, as shown in Fig. 2, were all that were necessary to improve the smoke haze.

For air jets to be as effective as the steam jets, it was found that the energy required in terms of equivalent pounds of steam would be 500 lb. per hour for the air jets and 360 lb. per hour for the steam jets. The air jets would also require an additional investment in fans and motors, whereas the additional investment for the steam jets was a negligible expense of piping.

Although no increase in efficiency was expected due to the use of the jets, an increase of two or three per cent resulted immediately after the installation of the jets as shown in Fig. 3. This figure shows the gross increase in efficiency above previous practice when fac-

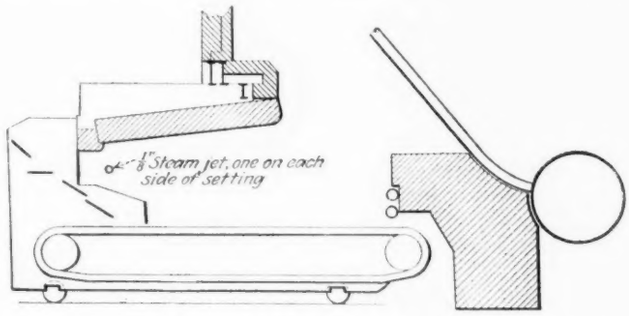


Fig. 2—Two steam jets near the front of the furnace improved smoke conditions

tors such as the effect of coal used, average rating and amount of banking are considered.

No good estimate of the net gain in efficiency can be made, as it is not necessary to use the jets continuously on all the boilers so equipped. If the jets were used continuously, however, a deduction of one per cent should be made from the gross gain in efficiency shown in Fig. 3.

The reason that no increase in efficiency was expected was that the combustion was comparatively complete before the gases left the furnace, which was also shown by the fact that the smoke without the jets was normally only a light haze. The cause of the increase was the fact that by the use of the jets steadier operating

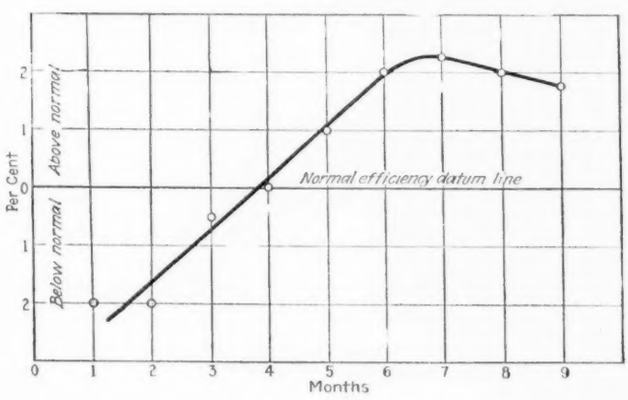


Fig. 3—Improvement in boiler efficiency due to use of steam jets

conditions were attained, which resulted in a lower ashpot loss.

The experiments described were made by R. L. Collier and C. B. Arnold, of the Steam Test Department of The Cleveland Electric Illuminating Company, under supervision of the writer.

[How another central station company secured similar results by injecting air over the fire was told in last week's issue in an article by A. E. Grunert, of the Commonwealth Edison Co., Chicago.—Editor.]

Swiss Boiler Generates 1,500-Lb. Steam Pressure in Two Stages

Steam from Low-Pressure Section (200 Lb. Pressure) Preheats the Feed Water to the High-Pressure Section. This Arrangement Reduces Size of High-Pressure Boiler and Gives It a Supply of Distilled Feed Water.

AT THE request of *Power*, Sulzer Brothers, of Winterthur, Switzerland, have furnished the following description of an experimental boiler, using a two-step process for the generation of steam at 1,500-lb. pressure. From Fig. 2 it will be noted that there are banks of tubes operating at different pressures, the front bank being in effect a separate high-pressure boiler and the rear bank a low-pressure boiler. The two pressures are 110 atmospheres (1,565 lb.) and 14 atmospheres (200 lb.).

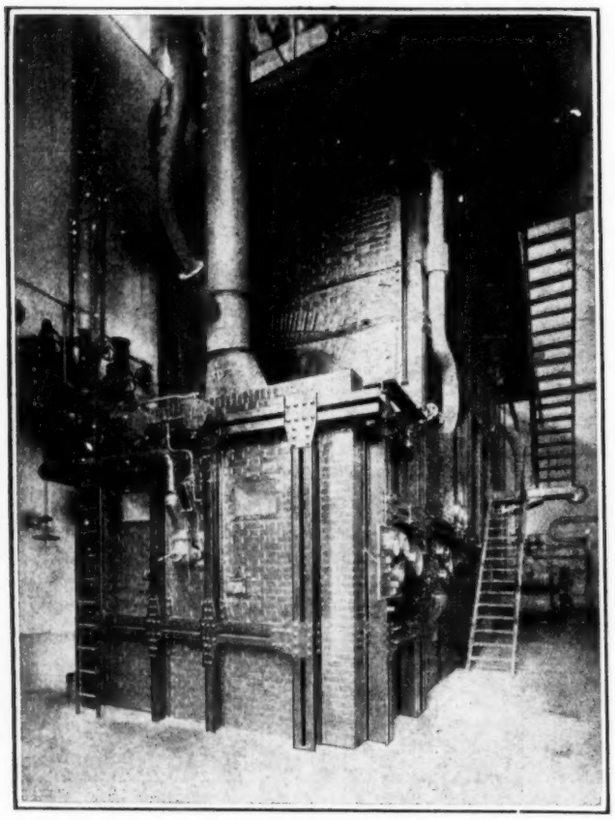


Fig. 1—View of high-pressure installation at Winterthur

Each of the two boilers is fitted with a special superheater. The high-pressure superheater is of the radiant-heat type and is built into the front wall opposite the high-pressure bank of tubes. The low-pressure superheater is of the usual construction and lies between the two banks of tubes; the gases can be diverted from it if desired.

The temperatures reckoned for the superheated steam were 707 deg. F. in the high-pressure and 662 deg. F. in the low-pressure boiler.

The heating surfaces in square feet are as follows:

High-pressure boiler	485
Low-pressure boiler	1,240
High-pressure superheater	85
Low-pressure superheater	430
Air heater (about)	1,940
Water screen (about)	95

The drum of the high-pressure boiler is seamless, being forged from one piece and the ends bent over; it was supplied by Messrs. Krupp and has the following dimensions: Internal diameter, 36 in.; wall thickness, 2.9 in. in the cylindrical part and 4.6 in. at the edge of the manhole; total length, 14 ft.; weight about 8½ tons.

The material is special nickel steel (5 per cent nickel) with a tensile strength of 30 to 37 tons per square inch and 22 tons per square inch elastic limit at 68 deg. F.

The steam collector, like the boiler drum, is a seamless body of the same material: Internal diameter, 28 in.; wall thickness, 2.08 in. in the cylindrical part and 3.35 in. at the edge of the manhole; length, 9 ft. 10 in.; weight, about 3½ tons. The tubes connection it with the boiler drum are beaded in.

There are 24 seamless high-pressure water tubes, external diameter 2.36 in., wall thickness 0.276 in. and average length 42 ft. Both ends of each water tube are beaded into the high-pressure drum.

These are seamless hot-rolled Mannesmann tubes, tested to 200 atmospheres (2,845 lb. per sq.in.) and are of specially selected quality, having a tensile strength of 24 to 29 tons per square inch with a minimum elongation of about 20 per cent.

The high-pressure superheater tubes are 1.26 in. in external diameter and 0.138 in. thick and made of the same material as the boiler tubes.

There is nothing special to mention with regard to the material used for the low-pressure boiler and its superheater.

The plant is fitted with an air heater arranged at the back of the low-pressure boiler and also an induced-draft installation. A pipe connects the air heater direct to the pulverized-coal burner.

The boiler is fired with pulverized coal. The furnace space measures 1,485 cu.ft. The front and side walls are cooled with air which circulates several times up and down in closed ducts from which it eventually passes to the air heater.

Coal is pulverized in a special machine, the rotor of which is fitted with freely pivoted beaters to grind the pieces of coal on the casing, which is grooved internally. The coal dust is introduced to the combustion space through a square-sectioned burner. The combustion air can be introduced through the burner or through

orifices at the sides. An oil burner placed just below the coal burner helps ignition of coal dust for starting.

A water screen is arranged in the combustion space a little above the floor level. It consists of eleven 3-in. seamless tubes and square-sectioned collectors and is connected up to the low-pressure boiler.

The boiler drums were submitted to thorough tests at the makers' works and also later by Sulzer Brothers at Winterthur, especially with regard to the guarantees given with respect to tensile strength and elongation. Special bending tests and notched-bar tests were also made by the makers and by Sulzer Brothers. Finally, very conclusive measurements were made of the stress and strain in the drums under hydraulic pressure.

Before fabricating the boiler, thorough tests had been made of the strength of joints made by beading the ends of thick tubes inserted in thick plates, as well as tests on the resistance of beaded tubes against being pulled out of the plates and also against buckling. It would lead too far to give details and results of these interesting tests here.

This two-pressure boiler system avoids the installation of expensive high-pressure heating surfaces in the region of low gas temperatures, where the heat transmission is necessarily low. The high-pressure boiler is fed solely with distilled water. The make-up water is distilled by means of low-pressure steam, which at the same time serves to preheat the high-pressure feed water.

Saturated steam from the low-pressure boiler passes into a heat exchanger, where it is condensed; the condensate is collected in a tank of about 4,400-gal. capacity; the cooling water of the heat exchanger is the raw feed water for the low-pressure boiler. This condensate, together with a much larger volume of returns from apparatus using high-pressure steam, is forced by a centrifugal pump at a pressure of 200 lb. through the heat exchanger, absorbs there the heat of the condensed steam and is then fed to the high-pressure boiler by means of the high-pressure feed pump.

In this manner all the heat of the low-pressure steam, except for losses in the pipes and by radiation, is recovered. The intermediate pressure stage of the high-pressure feed water in the preheater is essential for preheating to over 212 deg. F. In this manner preheating can be carried nearly up to the temperature of boiling corresponding to the pressure in the low-pressure boiler.

Two high-pressure pumps have been installed, each capable of supplying the boiler at full load at a pressure of 120 atmospheres (1,700 lb.). One of the pumps is driven by steam and the other electrically, an oil gear being fitted between pump and motor in order to avoid having to install a variable-speed motor.

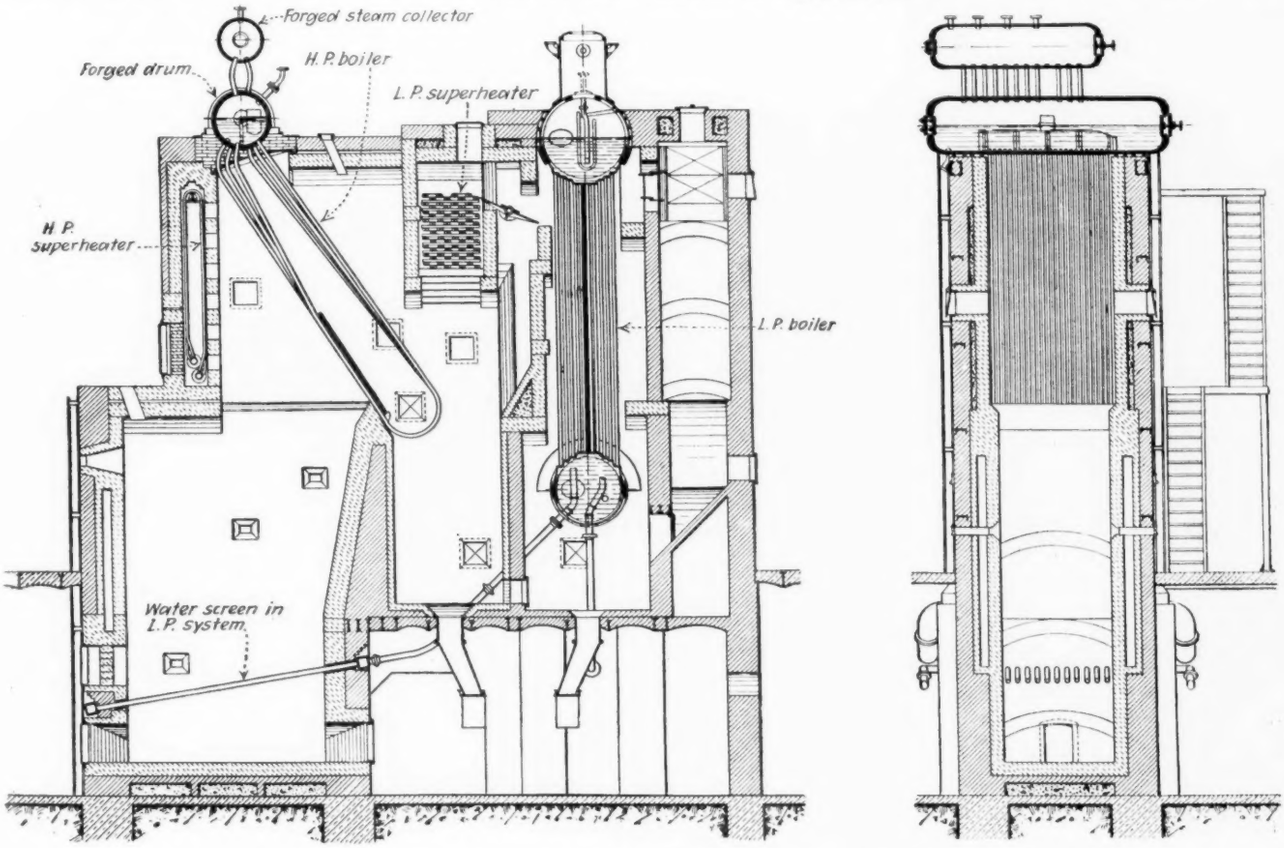


Fig. 2—Cross-section of boiler. Note relatively small heating surface of the high-pressure section

The high-pressure boiler generates normally 7,900 lb. of steam per hour and the low-pressure boiler 4,400 lb. The whole of this quantity of low-pressure steam is not required for preheating the high-pressure feed water.

The rate of evaporation in the high-pressure boiler amounts at normal load to 16.38 lb. per hour per square foot, or 14.6 lb. per hour per sq.ft. "from at" 212 deg. F. This high rate of evaporation allows a small heating surface to be adopted. The cooling of the tubes is, however, better on account of the small specific volume of the steam at the high pressure (0.263 cu.ft. per lb.) in comparison with low pressures. The specific

volume at 350 lb. gage, for example, is about five times greater.

The water for the boiler is obtained from the Winterthur town mains. The total hardness amounts to about 33 French degrees of hardness.

The water is first of all submitted to a preliminary cleaning in a purifier of special design and is then stored in a tank whence it is fed by means of a centrifugal pump into the low-pressure boiler against a pressure of 200 lb. per sq.in. A quantity of the steam raised in the low-pressure boiler corresponding to the amount of additional water required (about 5 per cent of the total amount of steam raised in the high-pressure boiler) is condensed in a condenser, whereby the total heat of the steam passes into the cooling water. As already explained, the cooling water is condensate from the condenser tank, which is passed by means of a centrifugal pump through the condenser and is there

TESTS WITH HIGH-PRESSURE BOILER
Sulzer Brothers, Winterthur (Switzerland)

Heating Surfaces:
High Pressure: Boiler, 485 sq.ft.; Superheater, 85 sq.ft.
Low Pressure: Boiler, 1,240 sq.ft.; Superheater, 430 sq.ft.
Water Screen: 95 sq.ft.; Air heater, 1,940 sq.ft.

No. of test	2	3	6	7	11	12
Duration of test, hours	9	8	8	8	8	8
Calorific value of coal, per lb.	13,500	13,500	13,500	13,500	13,660	13,660
Coal per hour, lb.	1,135	1,056	1,118	1,234	1,298	1,386
High-Pressure Boiler:						
Average pressure, lb. per sq.in.	694	917	1,190	1,296	1,435	1,448
Water evaporated per hour, lb.	5,487	5,100	6,838	7,377	6,967	7,357
Water evaporated per hour, per sq.ft., lb.	11.4	10.6	14.1	15.3	14.4	15.2
Temperature of superheated steam, deg. F.	522	590	606	608	(without superheater)	
Low-Pressure Boiler:						
Average pressure, lb. per sq.in.	170	175	171	171	189	188
Water evaporated per hour, lb.	3,586	3,285	3,595	3,667	4,576	4,596
Water evaporated per hour, per sq.ft., lb.	2.89	2.66	2.91	2.97	3.68	3.70
Gas temperature leaving boiler, deg. F.	644	577	554	579	630	617
Temperature of superheated steam, deg. F.	547	559	554	590	558	567

heated up to the corresponding steam temperature and is then fed to the high-pressure boiler at 110 atmospheres (1,565 lb. per sq.in.) by means of the high-pressure pump.

In the experimental plant the high-pressure steam is used for heating purposes in order to get operating experience.

When used for heating purposes, the steam at 110 atmospheres is passed through a reducing valve into the steam distributor and thence to the heating system. The condensate from the heating system flows back to the hotwell, thus completing the circuit. Any surplus steam raised in the low-pressure boiler is also used in the heating system. In this case the low-pressure boiler as well can be fed with condensate.

When used for generating mechanical energy, the super high-pressure steam passes from the boiler to the engine, and the quantity of steam that cannot be utilized in the heating system must then also be condensed. For this installation an auxiliary condenser would then have to be provided.

FLEXIBLE STEAM PIPE, like other "pressure vessels," is a possible source of danger, if not subject to proper handling and inspection. The Jan. 7 issue of *Engineering* reported the explosion of a pipe of this sort 3½ in. in diameter. It was made of bronze strips 0.047 in. thick coiled in the form of a helix and having the edges turned over so as to interlock. An asbestos cord packing preserved its steam-tightness. The pipe was not lagged and was therefore exposed to rapid heating and cooling as the steam was turned on or off.

Choosing a Welding Rod

BY R. W. BOGGS*

What should be the determining factors in the choice of one welding rod in preference to another? In the early days of oxyacetylene welding almost any sort of wire was used provided it filled the hole and was strong enough to hold together. But in these days of high-pressure work the requirements are much more stringent and we find considerable specialization in welding rods. The increased use of the oxyacetylene process and the ever-widening field of application has brought about a much-needed discrimination on the part of the user in his choice of supplies and equipment.

The best welding rods on the market today are the results of years of exhaustive research and experiment. When a welding rod is subjected to the flame of the blowpipe, it undergoes not only a physical, but also a chemical change. Various oxides are formed which should come to the surface of the molten metal and form a protective coating to prevent oxidation of the metal. Since the majority of the work encountered is veed out to facilitate the deep and perfect fusion of the pieces, it is imperative that the weld metal supplied by the welding rod should be of the best quality and produce metal in the joint of equal reliability to the rest of the metal. When a welding rod of poor quality is used, the resulting weld will have slag or oxide inclusions. With it the welder cannot do the work he could with good welding rod.

A welding rod that has been properly made will flow smoothly and readily under the oxyacetylene flame without sparks or fumes. When sparks are given off, some of the small pieces of burnt metal which fly in all directions will fall on the metal ahead of the weld and form a layer of oxide between the weld metal and the piece, thus preventing perfect fusion. It is also important that the welding rod chosen should give a strength equal to the strength of the original piece. This is obtained only by the use of a good quality of rod.

Another consideration, which at first seems petty, but which assumes a greater importance in handling large quantities of rod, is the matter of readily identifying the various rods. The different types of rod should be marked so as to be readily distinguishable one from the other. All steel and cast-iron rods that are subject to rust should be protected to prevent oxidation, using for this purpose materials that will not affect their subsequent use.

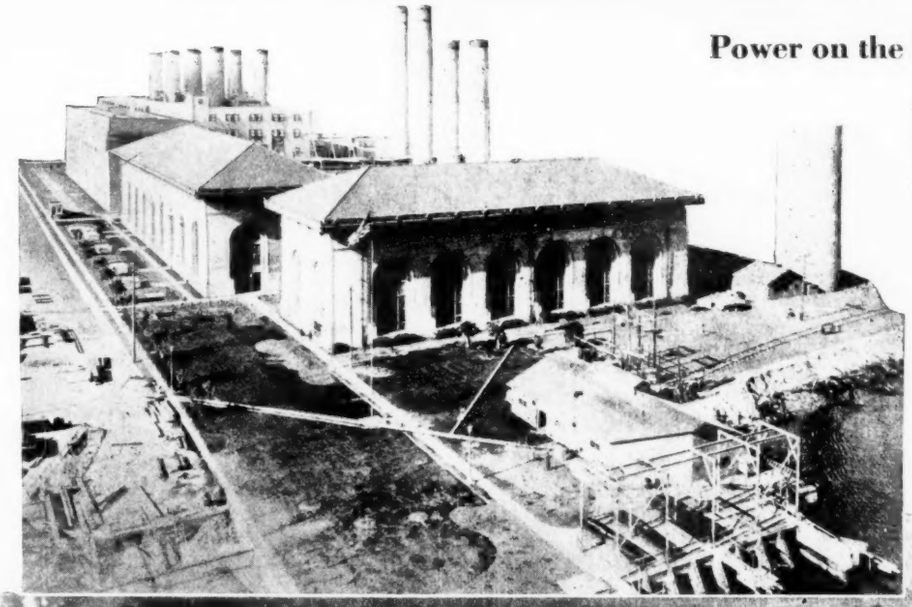
To sum up, the characteristics or factors that should be considered in choosing a welding rod may be enumerated as follows:

1. A composition such that the resulting weld metal will have the proper chemical and physical properties with respect to the base metal.
2. A composition such that the metal will flow readily and smoothly without excessive sparking.
3. The rod should be marked in some way so that it can be readily and accurately identified.
4. The rod should be purchased from a reputable manufacturer.

FOR ESTIMATES OF AN EXTREMELY ROUGH CHARACTER, where the range of pressure is not too great, it may be assumed that the volume of a given weight of saturated steam is inversely proportional to the absolute pressure.

*Oxweld Acetylene Company.

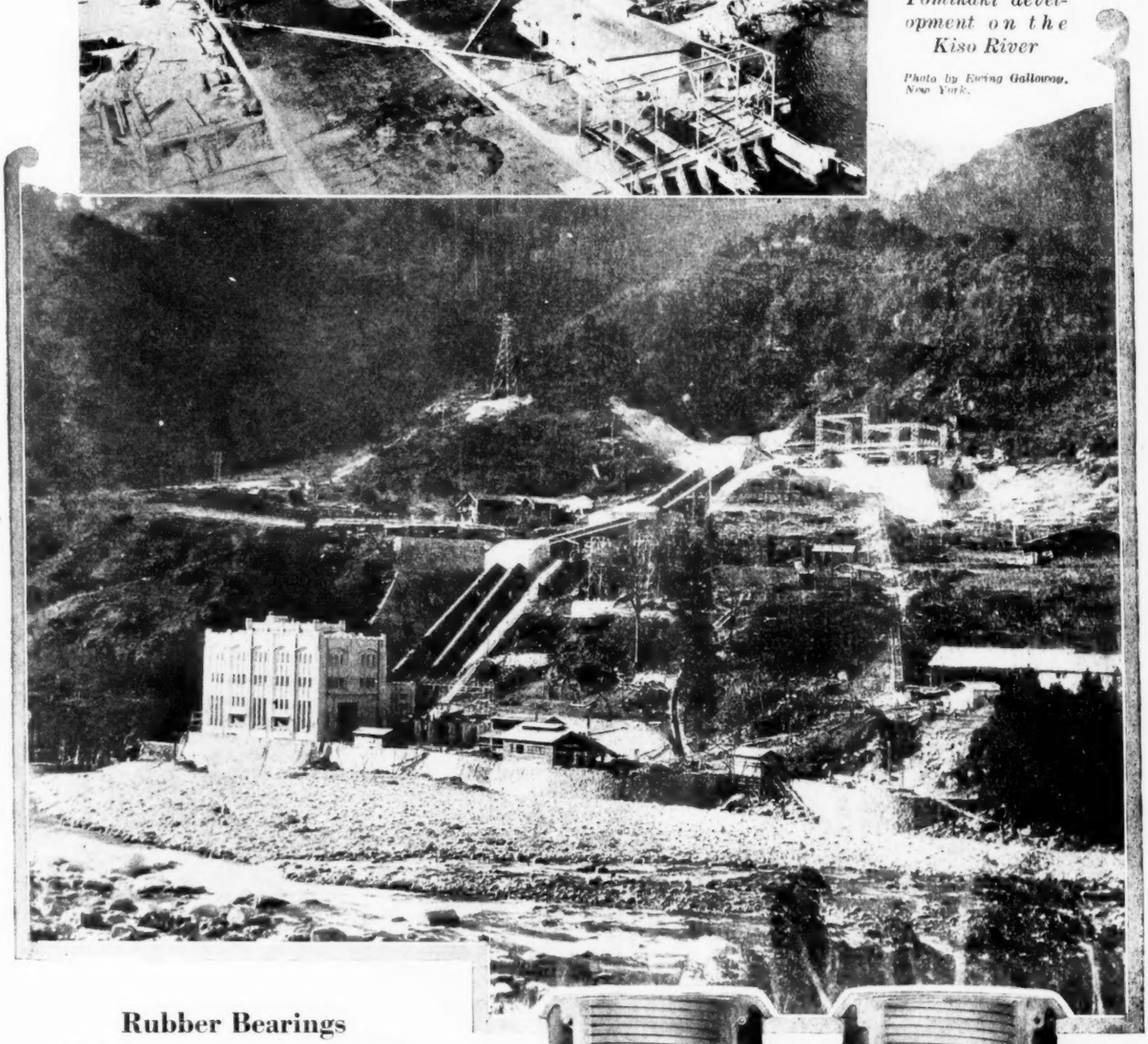
Power on the Pacific



Left—In California the Long Beach power station has been enlarged (new section shown in the background)

Below—Japan's growing use of water power is exemplified by this 40,700-kw. Yomikaki development on the Kiso River

Photo by Ewing Galloway, New York.

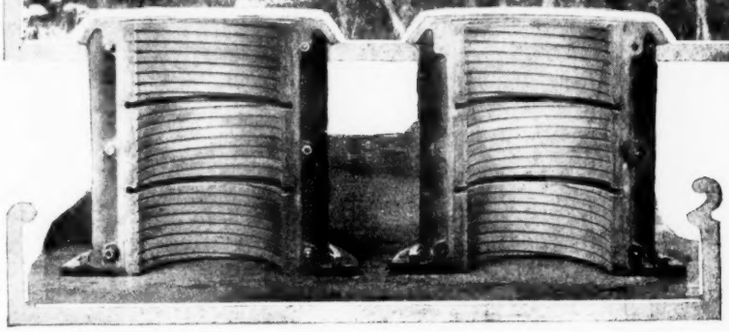


Rubber Bearings

Right—Bearings lined with rubber instead of lignum vitæ are now being used on vertical-shaft water turbines

The bearing shown is installed on an 18,000-hp. turbine in the Cheat Haven Station, West Virginia Power & Transmission Company.

Photo by courtesy of Wm. Cramp & Sons, I. P. Morris Dept.



Automatic Regulators Control Voltage Over Wide Ranges

IN MANY power systems conditions have arisen that require a much wider range of voltage control than can be obtained with the standard voltage regulator. To meet these new conditions, there has been developed what are known as broad-range regulators, and this article describes their operation and tells how to put machines into service where these regulators are used.

By W. H. TURNER
Central-Station Engineering Department, General Electric Co.

ON STANDARD alternating-current voltage regulators the relays are energized by the voltage of the exciter or exciters being controlled. As a vibrating voltage regulator automatically raises or lowers the exciter voltage with an increase or decrease of load, the strength of relay action necessarily

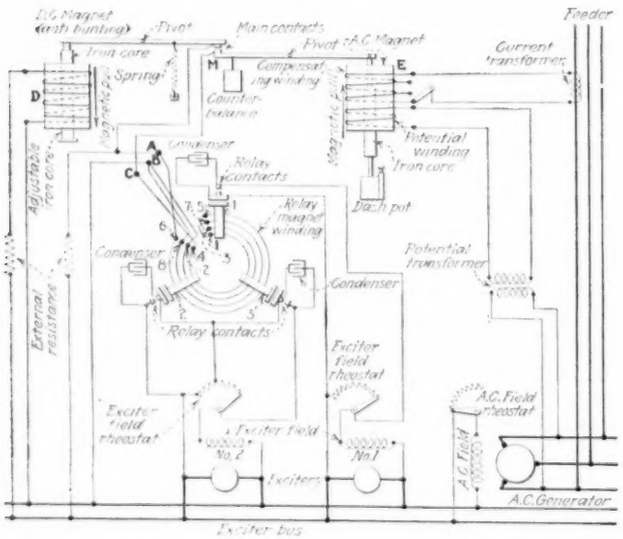


Fig. 1—Simplified diagram of a standard-voltage regulator operating on exciter voltage

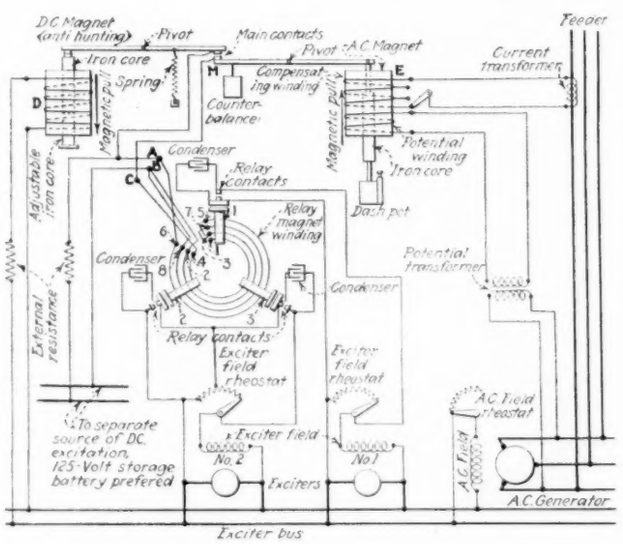


Fig. 2—Simplified diagram of a broad-range voltage regulator operating on separate excitation

increases and decreases in proportion to the exciter voltage, or in proportion to the generator's load. The standard voltage regulator operates satisfactorily on exciter voltage ranges of three to one, this range being usually sufficient for most generator installations. A standard 125-volt regulator will operate on exciter voltages varying from 45 to 135. A large number of modern generators require approximately 60 volts across the slip rings at no load, and about 110 volts at full load and 80 per cent power factor.

A diagram of connections for a standard type of voltage regulator is shown in Fig. 1. In this regulator the relay magnet is of the differential type. One coil of this magnet is connected directly to the exciter bus and the other coil is connected to this bus through the main contacts *M* of the direct-current and alternating-current magnets. As long as contacts *M* are open, only one relay soil is magnetized, and it attracts the relay armatures and opens their contacts as shown in the figure. With the relay contacts open, the rheostats are in series with the exciters' field windings, consequently the voltage of these machines and the alternating-current generators will tend to drop.

Direct-current magnet *D* is connected across the exciter bus. This magnet is arranged so that the pull on its movable core is downward. From this it can be seen that as the exciter voltage increases it will tend to open main contacts *M*, and as the voltage decreases these contacts will tend to close. On the alternating-current magnet *E* the pull tends to lift the core, so that with an increase in voltage the magnet would act to open contacts *M*, and when the voltage is decreasing the tendency will be for the contacts to close, as was the action for the direct-current magnet. Therefore, in operation, with a decrease in voltage the two magnets will act to close contacts *M*. When these contacts close, the circuit for the second coil in the relay magnet is completed. Energizing this coil demagnetizes the relay and releases the armatures and the relay contacts close. Closing of these contacts short-circuits the field rheostats of the exciters and the voltage begins to rise on the machines.

As previously explained, an increase in voltage causes the direct-current and alternating-current magnets to open contact *M*. When these contacts open, the relay magnet is again magnetized, the relay contacts opened and the rheostats are put in the exciter-field circuits.

These operations are repeated at the rate of about 200 to 300 times per minute. By this rapid cutting in and out of the field rheostats of the exciters, the voltage is held constant. A more complete description of the operation of the standard type voltage regulator appeared in the July 27, 1926, issue.

Broad-Range Voltage Regulators

Many synchronous condensers and some alternating-current generators require an excitation range greater than three to one. To meet these conditions a broad-range regulator is required. The cycle of operation of the standard regulator is not affected by exciting the relay coils from a separate, fairly constant, direct-current source as in Fig. 2, rather than from the exciter voltage. Separate excitation assures snappy, positive relay action irrespective of the exciter voltage and converts the standard-range voltage regulator to a broad-range type. A 125-volt battery is the usually separate source of excitation. This form of broad-range regulator is suitable for operation over exciter voltages of 10 to 125, or 20 to 250. Comparing Fig. 1 with Fig. 2, it will be found that the only difference in them is the method of exciting the relay coils.

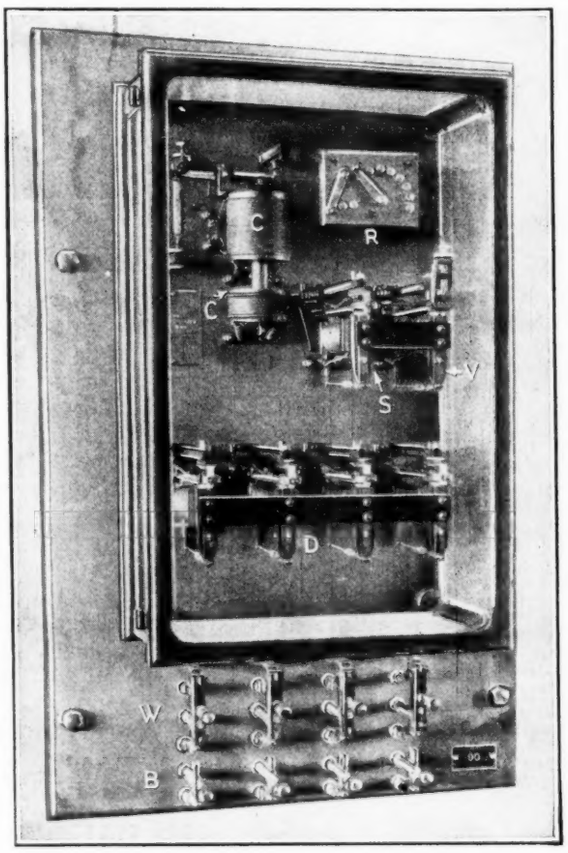


Fig. 3—Broad-range voltage regulator with alternating-current relays

C—Alternating-current coils on main magnet. *C'*—Direct-current coil on main magnet. *E*—Adjusting rheostats for main alternating-current coil. *S*—Stabilizing relay. *V*—High-voltage relay *D*—Vibrating relays. *W*—Relay contact reversing switch. *B*—Relay contact disconnect switches.

A new and different form of vibrating voltage regulator, Fig. 3, has been developed for application especially on synchronous condensers where a wide range of exciter voltage is required and there is no separate direct-current source available. The relays of this regulator are specially designed to operate on alternating current instead of direct, which allows the regulator to operate over wide exciter voltage ranges without special adjustment or separate excitation. No dashpot is used and the main control is simplified.

As with the standard voltage regulator, the alternating-current voltage of the generator or condenser is regulated indirectly by rapidly opening and closing a shunt circuit across the exciter field rheostat, as previously explained, thus varying the exciter voltage to maintain the desired alternating-current voltage.

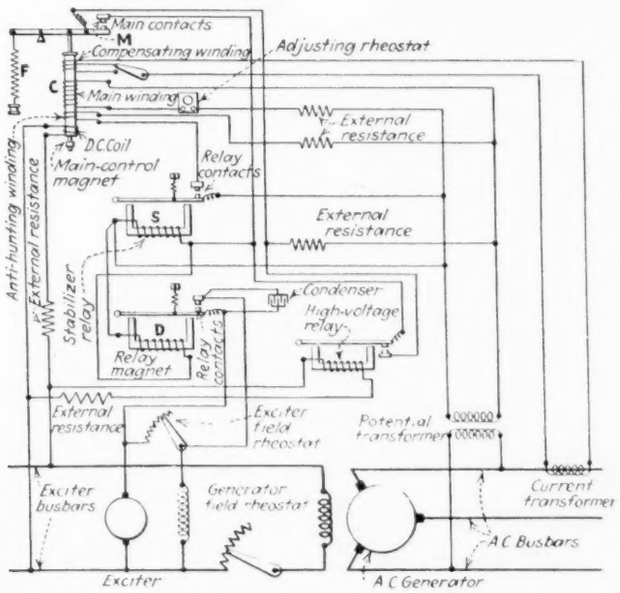


Fig. 4—Simplified diagram of the voltage regulator shown in Fig. 3

By referring to the elementary diagram, Fig. 4, it can be seen that on control magnet *C* the main alternating-current winding with its external resistance is connected across the secondary of a potential transformer. The magnetic pull of the main alternating-current magnet upon the laminated core is assisted by a helical spring *F*, the tension of which is adjustable. When the main contacts *M* of the regulator close, relay winding *D* is energized and the relay contacts open, with a resultant drop in exciter voltage and corresponding drop in alternating-current voltage. When the main contacts open, the relay winding is de-energized and its contacts in shunt with the exciter field rheostat close and cause the exciter voltage and alternating-current voltage to rise. By the aid of the stabilizer relay *S*, this cycle is repeated so rapidly that the regulator holds the alternating-current voltage constant and holds an average exciter voltage.

Use of Stabilizing Relay

The purpose of the stabilizing relay *S* is to increase the rate of vibration of the main contacts. Without the action of the stabilizing relay the alternating-current voltage would have to rise slightly before the main contacts would close, and the voltage would have to decrease a small amount before the main contacts would open. Thus, the resulting voltage would be unsteady. As stated, the action of the stabilizing relay

increases the rate of vibration of the main contacts and also prevents hunting as follows:

When the main control contacts close, which in turn energizes the relays, the contacts of the stabilizing relay open. This opens a small additional winding on the main control magnet that causes a slight decrease in magnetic pull and the main contacts open. This again closes the stabilizing relay contacts, which in turn closes the anti-hunting winding of the main control coil. Thus the action is again repeated and at a constant rate for any given condition of load, power factor and speed. Any large change in load causes the contact action to cease either in the open or closed position, depending on the way the voltage tends to change, until the voltage is restored near normal and the contacts will again vibrate at a constant rate so as to hold an average exciter voltage to maintain the alternating voltage constant. This form of broad-range regulator is suitable for operation for ranges of exciter voltages of 10 to 125, or 20 to 250 without separate excitation for relays.

Purpose of High-Voltage Relay

The high-voltage relay *V* is for the purpose of limiting the exciter voltage at any desired value so as to prevent overloading the generator or condenser being controlled. This relay has no effect until the exciter voltage reaches the value at which this relay is set. At this point this relay will take the control from the alternating-current main contacts and will hold the exciter voltage by rapidly opening and closing the relay contacts, thus holding full load upon the alternating-current machine until the overload condition is removed. From the wiring diagram it can be seen that the contacts of this relay and the main alternating-current contacts are in parallel.

The alternating-current control magnet consists of a coil with three windings, namely, the alternating-current main winding, which has the greatest effect upon the laminated core; the auxiliary winding, which forces the core to vibrate, and a series or current winding, taps of which are brought out to the dial switch shown in the upper right-hand corner, Fig. 3. When he current winding is connected to the secondary of a current transformer as shown in the wiring diagram, the regulator can be adjusted to compensate for line drop. The amount of compensation is adjusted by moving the two small levers of the dial switch. The switch at the left is for coarse adjustments, while the switch at the right is for fine adjustments.

The direct-current coil shown under the alternating-current coil is to give a means of adjusting the compounding of the regulator. The effect of the direct-current coil upon the laminated core is very slight, but increases in proportion to the exciter voltage. The compounding is changed by raising or lowering the core upon a threaded core stem.

Putting the Regulator Into Service

To put the regulator into service, the alternating-current voltage should first be set by hand at the desired value with the cutout switches at the bottom of the regulator open. By turning the adjusting rheostat, which is in the main alternating-current coil circuit, it should be possible to cause the main contacts to remain closed, to vibrate, or to remain open. This test is an excellent check on the action of the stabilizing relay. The adjusting rheostat should be turned until the relay contacts just cease to vibrate and are open. At this point the cutout switches at the bottom of the regulator should be closed and the exciter field rheostat slowly turned to the predetermined operating point. As the exciter-field rheostat is put in circuit, the alternating-current voltage will tend to drop slightly, but this drop can be compensated for by slightly changing the setting of the adjusting rheostat.

Extremely Broad-Range Voltage Regulator

Some condenser applications at times require zero volts across the slip rings; whereas even the broad-range regulator can only approach residual voltage of the exciter. The most practical way to meet the zero requirement is to assist either form of broad-range regulator by adding a special control relay which cuts in a portion of the main field-rheostat when the exciter voltage is low. The vibrating element is the master control of the alternating-current voltage at all times. There is no hunting between the regulator and relay, for the relay cuts in the main rheostat slowly and there is a zone of approximately 10 volts between the closing of the cut-in contacts and the closing of the cut-out contacts. The vibrating regulator is a fast control and holds the alternating voltage constant, even while the main field rheostat is being cut in or out.

Lubricating Elevator Worm Gears

The kind of oil to use in the gear cases of elevators is a somewhat disputed question, but it is generally agreed that it must have sufficient body to stand the heavy pressure it is subjected to on the gear teeth, without allowing metal-to-metal contact with the worm. It should also be free from alkalies and acids. This is particularly true where ball or roller bearings are used, since their service efficiency is seriously impaired by even slight pitting of their surfaces. Elevators are frequently located where they are subjected to wide ranges of temperature, from the intense heat of summer to the lowest temperatures of winter. In such cases it is important that the oil should not be seriously affected by a change in temperature.

Successful lubrication of worm gears has been accomplished with a straight mineral oil such as a high-grade steam cylinder stock having a flash point around 600 deg. F. and a viscosity of about 150 sec. Saybolt at 210 deg. F. Other recommendations are for a straight mineral oil having a viscosity of about 120 sec. at 210 deg., but with a pour test much lower than cylinder stock. Oil containing such fillers as graphite have been used. Then again, castor oil has many adherents, and as high as 50 per cent castor has been used in worm-gear lubricants.

Where castor oil is mixed with straight mineral oil, there is always the danger that the two oils will separate in the gear case. This can be prevented if the oils are properly compounded. Where castor oil is used, care should be used to obtain the genuine product and not one of the substitutes on the market. In view of this wide variation of opinion it will be well to consult the elevator manufacturer or the engineers of a responsible lubrication company if trouble is being experienced with the problem. Most elevator manufacturers have lubricants that they recommend for use in the gear cases of their machines. One thing to keep in mind is, that the proper kind of oil is the cheapest kind of maintenance. Any attempt to save at the expense of lubrication quality is false economy.

Improving Heat Transfer in Refrigeration Evaporating Apparatus*

By THOMAS SHIPLEY†

TWO YEARS' investigation made by the Research Department of the York Manufacturing Company to determine heat transmission through the surface of evaporating apparatus under varied operating conditions, resulted in new designs of coils from which rates of heat transfer up to 180 B.t.u. were obtained as compared to 15 B.t.u. in the average plant.

IN THE investigation the principal object was to discover if possible a design or a method of operation or both that would increase the efficiency and improve the practical operation of refrigerating apparatus, so the tests were confined to apparatus and methods generally used in commercial installations.

Tests on Shell-and-Tube Cooler

To secure more reliable data on the efficiency and capacity of the shell-and-tube cooler, while being operated under different ammonia heads, was the first effort. Determining the average heat transfer obtainable per square foot of surface per hour per degree of mean temperature difference, made it possible to determine the most effective head at which the liquid should be maintained when operating this type of cooler and also the relative value of liquid versus vapor surface in an ammonia evaporating apparatus of any design.

In Fig. 1 are shown the four sections of the cooler and the levels at which the liquid ammonia was held during four series of tests. The cooler was 34 in. outside diameter by 16 ft. long outside of tube heads, with seventy-two 2½-in. tubes having a total surface of 750 sq.ft. The brine traveled through eight passes and in the first tests entered at a temperature of 17.9 deg. F.

TABLE 1—RESULTS OF TESTS ON SHELL AND TUBE COOLER

	17.9 Deg. Brine In				34 Deg. Brine In			
	A	B	C	D	A	B	C	D
Brine temp., deg. F.	17.6	17.9	17.9	17.8	34.3	34.0	33.9	33.6
Suct. pres. at cooler, lb. G.	14.9	13.9	10.6	6.3	24.6	22.7	18.0	10.5
Superheat at cooler, deg. F.	3.4	7.3	13.3	23.0	3.5	7.8	14.5	28.7
Tons of refrigeration	61.4	59.0	51.3	41.0	79.2	75.5	66.2	49.8
Tube surface below liq. level, per cent	87.5	62.5	37.5	12.5	87.5	62.5	37.5	12.5
Ht. of Nh3, in.	26.4	20.0	13.4	6.5	26.4	20.0	13.4	6.5
Mean temp. difference	15.5	17.3	22.7	30.6	19.3	21.3	27.5	38.9
B.t.u. transfer per sq. ft. per hr. per deg. m.t.d.	62.5	54.5	36.4	21.5	68.4	56.8	38.6	20.5
Brine velocity, ft. per min.	129	131	134	133	133	133	135	133

Table I gives a summary of the conditions under which each of these runs was operated and the results obtained. During these runs the entering brine temperature, velocity of brine and the speed of the compressor were kept as nearly constant as possible. Each series of runs was repeated several times so that the figures given are averages.

As a check on the heat transfer and the other variables, several series of runs were made under different brine temperatures. In the right half of Table I is given a summary of the results obtained when the entering temperature of the brine was increased to 34 deg., the cooler being operated under conditions similar to those for the left half of the table as to liquid ammonia content and velocity of brine flow.

An examination of the data discloses the fact that the average heat transfer per square foot of surface changes with each change of liquid level, and that the higher this level is kept, or, in other words, the larger the surface in contact with the liquor, the greater is the average heat transfer. It also will be seen that the change of temperature conditions and the consequent change in work done do not materially affect the heat transfer per square foot, per degree of mean temperature difference per hour.

Tonnages given in the table do not vary directly as

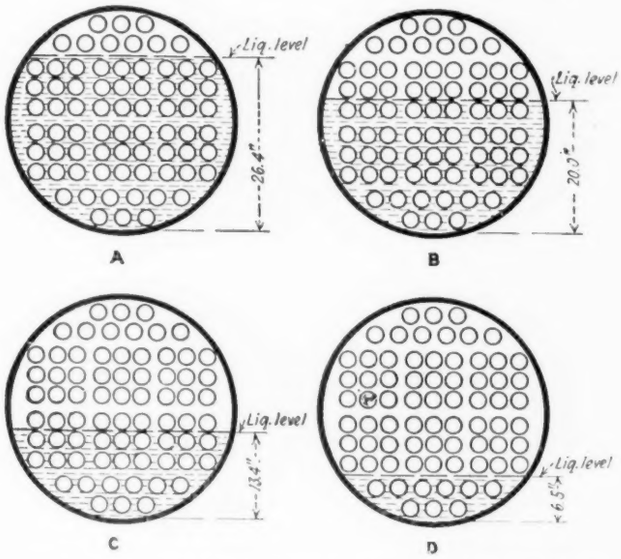


Fig. 1—Liquid levels used in tests on shell-and-tube coolers

the tube surface in contact with the liquid, for the reason that, as the level of the liquid is lowered, thereby reducing the square feet of wetted surface, the evaporation pressure falls, as does the temperature of evaporation, with the result that the temperature range between the brine and ammonia increases. This, in turn, keeps the tonnage from following directly the variation in square feet of effective evaporating surface.

Another point of interest is that, as the level of the liquid is lowered, the superheat of the gas leaving the cooler is increased. In cooler operation the superheat of the gas is one of the most reliable indications as to the whereabouts of the liquid level.

*Abstract of paper presented at annual convention of National Association of Practical Refrigerating Engineers, Kansas City, Mo., Nov. 2-5, 1926.

†General manager of the York Manufacturing Co.

Investigations were made next on evaporating coils with particular attention to the variations in brine velocity over the surface of the coils and the relative efficiency of the "expanding" versus the flooded method of feeding liquid ammonia into the evaporating system, when operating under high velocity conditions.

Fig. 2 shows three types of coils that were used, each containing 500 ft. of 1¼-in. full-weight pipe. In

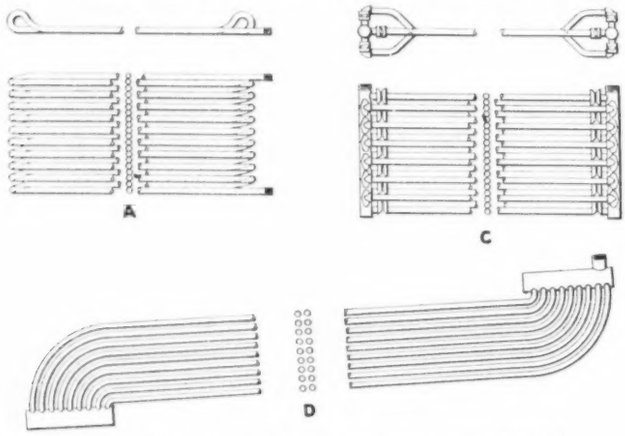


Fig. 2—Design of the expansion coils tested

the drawing *A* represents a continuously wound coil, having a special bend making it possible to build one pipe on top of another. This coil is 20 pipes high and 25 ft. long. Coil *C* has a vertical header at each end, is 20 pipes high, 25 ft. long between headers and has 20 connections to each header. Coil *D* has a double row of runs, each 10 pipes high. Each pipe is a separate run and is 25 ft. long. The coil is shaped like a steam-heating surface and has horizontal headers.

Tests With Continuous Costs

Table II gives a summary of the results of a number of runs on each of the coils. During the tests the coils were operated under the expanding method of liquid feed, being so regulated that the average temperature of the gas leaving the coil showed a superheat of 3 deg.

TABLE II—RESULTS WITH CONTINUOUS COILS OF FIG. 2

	A	C	D
Feet of 1¼-in. pipe	500	500	500
Suction pressure, lb. gage	19.6	17.5	21.5
Superheat, deg. F.	3.0	3.0	3.0
Brine temperature, deg. F.	14.0	14.0	14.0
Brine velocity, ft. per min.	133	133	133
Tons refrigeration	7.3	6.7	9.0
B.t.u. transfer	43	31	69

The final temperature of the brine was kept at 14 deg. F. The speed of the compressor was changed to hold the brine temperature. No suction liquid separator was used. The brine velocity was kept at an average of 113 ft. per minute.

A comparison of results led to the conclusion that long coils were not so effective as short ones, provided the short coils were designed so that the liquid could be fed into them evenly and the discharge end was not restricted. The effect of using vertical versus horizontal headers is shown in the results obtained from coil *C* and coil *D*.

Tests on Flooded Coils

After investigating the possibilities of coil evaporating systems with brine velocities up to 350 ft. per min. while using the expanding method of feeding, tests were run on the same evaporating systems under flooded liquid feed conditions and similar brine velocities. Referring to Fig. 3, coils *A*, *C* and *D* were the same as used in Fig. 2 and coil *B* is coil *A* split into two sections, connected together to make one coil. To produce a real flooded condition, a liquid accumulator was placed at such a height as to provide a column of liquid 12 ft. high above the top pipe of the coil tested. This static head was needed to overcome the friction head found to exist in some designs of coil.

To determine the effect of the liquid-feed head, the liquid accumulator was lowered by regular increments until the accumulator reached the top of the tank. Under the same conditions as to the suction pressure at the compressor, it was discovered that a high liquid head would give a better transfer of heat per square foot of surface than could be obtained at a low liquid head. The reason advanced was that the gas, being under a heavier pressure, occupied less space, so that the wetted surface was greater. On the other hand, the high liquid head raises the pressure under which

TABLE III—RESULTS WITH FIG. 3 COILS

	A	B	C	D
Feet of 1¼-in. pipe	500	500	500	500
Suction pressure, lb. gage	19.6	21.2	18.9	21.5
Brine temperature, deg. F.	14.0	14.0	14.0	14.0
Brine velocity, ft. per min.	133	133	133	133
Tons refrigeration	7.3	9.0	12.0	15.7
B.t.u. transfer	43	68	66	120

the coils are operating, which in turn raises the possible temperature that the coils can produce. Results of the tests on the four types of coil are given in Table III.

Having obtained the greatest transfer of heat by using short coils under flooded liquid feed conditions,

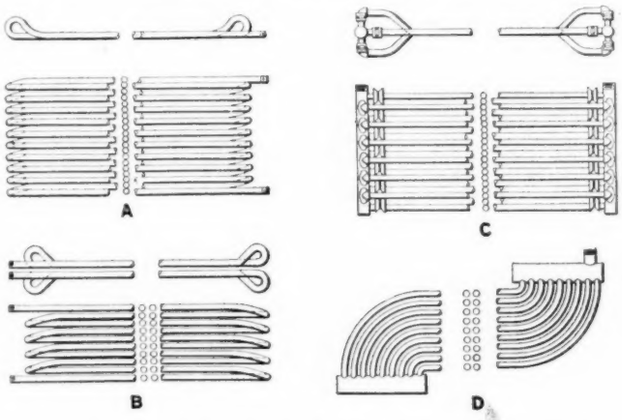


Fig. 3—Flooded coils tested, with results given in Table III

and high brine velocity, the results were checked by making up two more coils, one following the design of coil *D*, but with 12 runs of pipe instead of 20 and having a total of 137 sq.ft. of surface. This is coil *E* in Fig. 4. The second coil was made up of two horizontal headers, 3 ft. apart center to center, connected by short vertical lengths of 1¼-in. pipe. This is coil *F* in Fig. 4. It is the extreme for short pipe lengths and has 137 sq.ft. of surface. A shell and tube cooler *G* having the same amount of surface as the coils, was built and used in the final runs along with the two types of coil mentioned. The results appear in Table IV.

Summarizing the results, the runs on the shell-and-tube coolers included operating conditions in which 12½ per cent of the tube surface was covered by the liquid

to conditions where the whole surface was covered, as in the case of cooler *G* in the final runs. The test figures showed conclusively that to obtain the best operating results from such apparatus, the shell should be

TABLE IV—TESTS WITH FLOODED COILS

	E	F	G
Square feet of surface	137	137	137
Suction pressure, lb. gage	21.6	21.3	21.2
Brine temperature, deg. F.	14.0	14.0	14.0
Brine velocity, ft. per min.	133	133	133
Tons refrigeration	9.4	10.4	6.7
B.t.u. transfer	120	132	80

filled as nearly as possible with liquid, for the surface performing the useful work is that in contact with the liquid. There was no gain in superheating the gas. Relatively, these results held good for all brine velocities for such apparatus.

High Brine Velocity Over Coils Desirable

Results obtained with the coil evaporating system were a long step in advance of what has heretofore been considered good practice. An analysis disclosed the fact

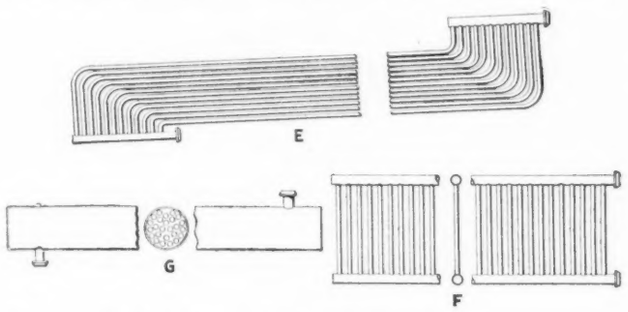


Fig. 4—Tested long-coil and shell-and-tube evaporators

that high brine velocity was a dominating factor in the results obtained, and that this high brine velocity could be obtained only by encasing the evaporating system and treating it as a separate unit. This construction eliminates the commonest ice freezing system in use today, that of setting coils vertically between the cans. Taking advantage of the higher brine velocities also eliminates long coils in freezing tanks. The reason for this may be explained when it is considered that increased brine velocity means increased evaporation of liquid within the coils. Producing an increased amount of gas causes an acceleration in the gas speed within the coil, which means friction and also increases transmission of heat by reason of the speed at which the gas rubs the liquid against the inner surface of the coil.

Short Coils Best

While this action is conducive to better results, while there still remains particles of liquid in the coil, as soon as the liquid is all evaporated, the coil becomes a gas passage wherein no heat is taken up, except the small amount necessary to superheat the gas itself. The point at which the evaporation ceases, is the point marking the useful length of the coil for the conditions under which it is operating. Thus, the limitation of the useful length of the pipe in a coil depends upon the rate at which the evaporation takes place within it.

For example, coil *A*, Fig. 2, is 500 ft. long. Under a brine velocity of 133 ft. per min., it gave an average transfer of 43 B.t.u. with expanding liquid feed conditions, and no better results could be obtained under flooded feed conditions. When it was cut in half and made into two sections of 250 ft. each, combined into coil *B*, Fig. 3, a 58 per cent increase was obtained in the transfer of heat under flooded feed conditions. Again, coil *D* with 25-ft. lengths of pipe and the same total area of pipe as in coils *A* and *B*, showed a 60 per cent increase under expansion feed conditions and an increase of 179 per cent under flooded feed conditions.

These results were considered conclusive evidence that the length of the pipe making up an evaporating system must be governed by its internal diameter and by the work being done within the coil, no matter how the work may be produced. The effect of internal velocity—that is, the velocity within the evaporating space, that causes the liquid ammonia to be spread or rubbed rapidly over the internal evaporating surface—is to increase the effectiveness of the surface. Referring to Fig. 4, *E* and *F* are examples of coils in which the internal velocity is rapid, and cooler *G* is an example of slow velocity. The transfers of heat given in Table IV are: Coil *E*, 120 B.t.u.; coil *F*, 132 B.t.u., and cooler *G*, 80 B.t.u. The coils and the cooler have exactly the same amount of evaporating surface, namely, 137 sq.ft., and were operated under exactly the same conditions.

Better Results from Flooded Operation

The great gain in heat transfer obtained by feeding the liquid into an evaporating system under flooded conditions establishes this method as the best for the purpose.

As a result of the tests the general rule of 15 B.t.u. for freezing tank coils has been placed upon the shelf. A rating requiring one foot of pipe to do the work formerly done by five feet is considered safe, and having obtained a transmission of over 180 B.t.u., the company will not be content for long with the present adoption of 75 B.t.u. for commercial practice, so that farther reductions in the surface required in such apparatus may be expected.

High-Pressure Gage Glasses—In *Power* for Nov. 9, 1926 (page 717), it was stated that the gage glasses on the 1,350-lb. boiler in the Lakeside Station of the Milwaukee Electric Railway & Light Co. were of the flat glass type "with the water in direct contact with the glass, no mica being interposed, as has been done in some other installations." It has been pointed out that this is incorrect. Experience with various types of glass in contact with water at the boiling point indicates that at pressures of 500 or 600 lb. per sq.in. there is great difficulty in maintaining steam-tightness; above that it is almost impossible. Moreover, if the glass is not protected by mica, the surface is rapidly dissolved by the water, and in a short time it is impossible to see through the glass. The boiler gages furnished by the Babcock & Wilcox Co. for the Lakeside Station, therefore, have mica interposed between the water and the glass.

The Matter of Constant, Steady Pressure and uniform flow is most important for the successful burning of fuel oil. It is obtained only by a properly arranged pumping system and careful attendance. Unsteady pressure may cause vibration in the furnace, which arises from an unsteady flow of oil from the burner tip. The pump pressure should never exceed 180 pounds with steam atomizers.

Calculating the Characteristics of the Extraction Turbine

Why an Extraction Turbine Has a Greater Throttle Flow—Selecting the Bleeding Stages—Determining the Increase in Throttle Flow To Offset Steam Bled—Proportion Bled for Feed Heating—Effect of Extraction on Steam Rate and Efficiency

By ROBERT R. WALDEN*

ENGINEERS are becoming more and more interested in the extraction turbine and often ask why the amount of steam used by such a turbine should be greater than by a non-extraction turbine.

Increased Throttle Flow and Decreased Condenser Flow with Extraction

When operating extracting, more steam is required because the steam that is bled expands only part of the way through the turbine and hence cannot do as much work as it would if it expanded completely to condenser pressure. Thus additional steam has to be admitted to do the work that the extraction steam has not accomplished.

On the other hand, the steam that is bled does some work before it leaves the turbine, and so less steam has to pass all the way through the turbine to the condenser than if the former were operating straight condensing. Summarizing, extraction turbines have a greater throttle flow but a smaller condenser flow than if they were operating at the same capacity straight condensing. The advantage of extraction results from the reduced loss in the circulating water, the energy from the bled steam being usefully applied.

Less steam will have to be supplied at the throttle for each thousand pounds extracted as the bleeding point is taken nearer the last stage. This is because the farther the steam expands through the turbine before being bled, the greater is the work it can do.

In some cases the steam extracted is used for feed-water heating, in others for such purposes as processing or to operate a small turbine. In the latter case there might still be some heat available for heating purposes from the exhaust of the turbine.

Many engineers desire to calculate the steam requirements for a given installation without going into too much detail. The following methods give sufficiently accurate results for general purposes.

In the design of a turbine for the purpose of developing power and at the same time to extract from one or more stages a certain amount of steam for other purposes such as feed-water heating, the total power required must first be considered, then the temperature to which the water is to be heated and the stages from which the steam is to be bled.

In order to illustrate the principles involved, suppose it is desired to extract steam from a 9-stage, 20,000-kw. turbine to heat feed water returning from its condenser to the boilers to not more than 275 deg. F. The steam is supplied the turbine at 215 lb. per sq.in. absolute, superheated 120 deg. F., and the back pressure is 1.5 in. of mercury absolute. At the rated load there is a drop in pressure across the throttle valve of 15 lb. per sq.in. and the steam rate, bleeding, is 12.84 lb. per kw.-hr. The pressures leaving the nine stages are respectively 118, 77, 45.25, 26.5, 14.0, 7.3, 3.6, 1.75 lb. per sq.in. absolute and 1.5 in. of mercury absolute. The first-stage efficiency may be taken as 68 per cent and that of the remaining stages as 81 per cent.

Division of Work in Turbine Determined by Stage Pressures and Efficiencies

The figure shows, on a Mollier diagram, the characteristics of the expansion of steam through the turbine. State *a* is the condition of the steam entering the throttle valve. The drop in pressure of 15 lb. per sq.in. across this valve takes place without change in the heat content of the steam, and the condition entering the first stage is shown by *b*. Were the turbine perfect, the process in the turbine would be *be* and the mechanical energy delivered by the turbine would be $h_b - h_e$ where the symbol h is used to denote the heat content of the steam.

The real turbine is not perfect, however, as is evidenced by the quoted stage efficiencies. In the first stage the pressure drops from 200 to 118 lb. per sq.in. absolute. If the stage efficiency were 100 per cent, the steam would leave this stage in state *c*. The stage efficiency is only 68 per cent, however, which means that 32 per cent of the energy represented by the so-called "adiabatic heat drop" $h_b - h_c$ is not transformed into mechanical work, but is dissipated as heat and reheats the steam. Thus the condition of the steam leaving the first stage and h_1 is given by the expression $h_b - h_1 = 0.68\,(h_b - h_c)$ = the work done in the first stage of the turbine.

The condition of the steam entering the second stage is 1 and the condition leaving, found from the stage efficiency in the manner just outlined, is 2. The locus of *b*, 1, 2, etc., gives the condition curve of the turbine which is the locus of the state of the steam between the stages of the turbine.

The table shows the results of these calculations for the characteristics of the turbine. In this table the heat content between the stages is found as just outlined. The drop in the actual heat content across a stage measures the work done on the rotor per pound

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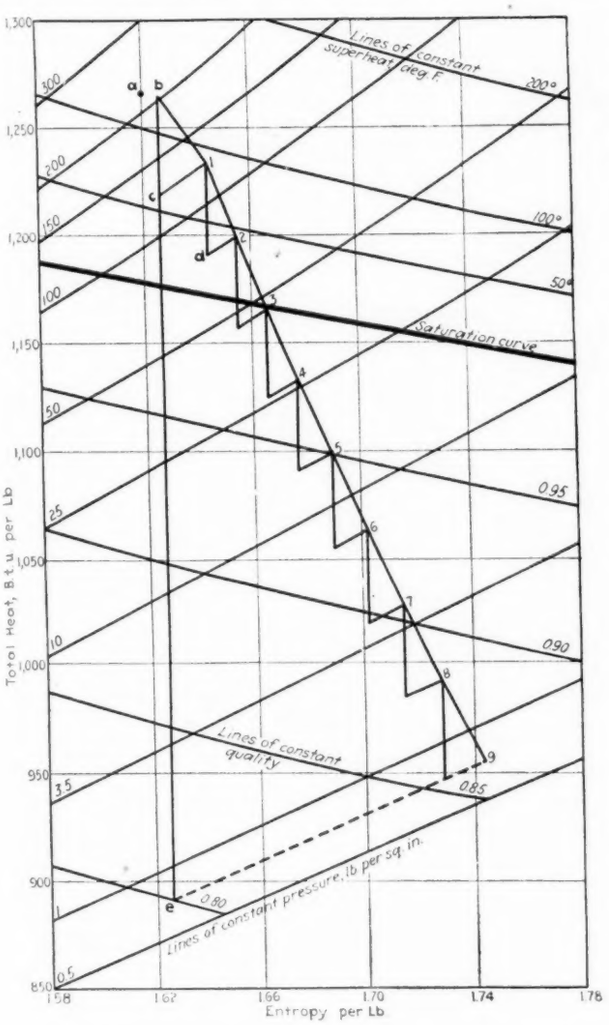
of throttle steam when operating straight condensing, this work being about equally divided between the nine stages.

Since the saturation pressure corresponding to the desired maximum feed-water temperature of 275 deg.



The state of the steam at various points through the turbine is shown on the Mollier diagram

F. is 45.4 lb. per sq.in. absolute, the high-pressure bleeding point for the steam can be taken as the third

DETERMINATION OF THE DIVISION OF THE WORK BETWEEN THE STAGES OF THE TURBINE

Stage Number	Heat Content Entering Stage, B.t.u. per Lb.	Work on Rotor per Stage, B.t.u. per Lb.	Work Done on Rotor Between Bleeding Points, B.t.u. per Lb.	Pressure Before Stage, Lb. per Sq. In. Abs.	Quality Before Stage, per Cent	Temperature Before Stage Deg. F.
1	1,269.3	30.8	....	200	.....	.....
2	1,238.5	34.4	99.6	118	.....	.....
3	1,204.1	34.4	....	77	.....	.....
4	1,169.7	34.6	69.5	45.25	99.7	274
5	1,135.1	34.9	....	26.5	.....	.....
6	1,100.2	35.0	70.4	14.0	95.0	209.5
7	1,065.2	35.4	....	7.3	.....	.....
8	1,029.8	36.0	....	3.6	90.6	148.3
9	993.8	36.0	....	1.75	.....	.....
To condenser	957.8	....	....	....	....	92.0
Totals	.....	311.5	....	....	....	.....

stage, this stage pressure being 45.25 lb. per sq.in. absolute at full load.

Since the temperature of the condensate leaving the hotwell is 92 deg. F., it is logical to introduce more bleeding points between the condenser and the third stage so that cooler steam will be utilized to heat the cooler feed water and greater efficiency attained. Suppose two intermediate bleed points are chosen. If the construction of the turbine is such that these can be located at the fifth and seventh stages, such would result in a well-balanced design. With more stages in the turbine the choice of these intermediate bleeding stages might easily demand an exhaustive study. However, in this case the possibilities are limited and the choice simplified.

Increased Throttle Flow Due to Extraction Computed from Division of Work Between Stages

As already noted, the bled steam does not do as much work as it would if it passed completely through the turbine, and additional throttle steam must be provided to make up this deficiency. Using values from Table I, the steam bled from the third stage does only $\frac{99.6 \times 100}{311.5}$ = 32 per cent as much work as it would if continued through to the condenser. Hence, 0.68 lb. of steam must be added at the throttle per pound of steam bled at the third stage to maintain the output, or 680 lb. per 1,000 lb. bled.

In a similar manner it is found that 456 lb. of steam must be added for each 1,000 lb. at the fifth stage and 229 lb. for each 1,000 lb. bled at the seventh stage.

It is obvious that, if the turbine is designed for bleeding, this additional flow in the first portion of the turbine and the consequent reduction of flow in the last portion will require increased and decreased areas or modified angles in the nozzles and blading for best design.

Heat Balance in Feed-Water Heaters Determines Amount Bled

Assuming that the rise in temperature of the feed water between heaters equals the difference between the bleeding steam temperatures, from Table I, the rise in temperature in the low-pressure heater is 148.3 — 92.0 = 56.3 deg. F.; in the second heater, 209.5 — 148.3 = 61.2 deg. F.; and in the high-pressure heater, 274 — 209.5 = 64.5 deg. F.

In any of the heaters the heat absorbed by the condensate must equal the heat given up by the steam bled. Or, for the high-pressure heater

$$W(q_3 - q_5) = W_3(h_3 - q_3)$$

where W = Weight of steam passing the throttle of the turbine;

q_3 = Heat content of the liquid at the third-stage bleeding pressure;

q_5 = Heat content of the liquid at the fifth-stage bleeding pressure;

W_3 = Weight of steam bled at the third stage;

h_3 = Heat content of the steam bled at the third stage.

From this equation the steam bled at the third stage is

$$X_3 = \frac{W_3}{W} = \frac{q_2 - q_5}{h_3 - q_3} = \frac{243.8 - 177.5}{1168.8 - 243.8} = 0.0717$$

= 7.17 per cent of throttle flow.

In the fifth-stage heater the steam condensed in the third-stage heater is mixed with the extracted steam and must be accounted for in determining the proportion bled.

That is, there are two sources of heat in this heater: (1) Steam from the fifth stage, which is condensed, and (2) hot condensate from the third-stage heater, which is cooled. Thus, for this heater,

$$W_5(h_5 - q_5) + W_3(q_3 - q_5) = W(q_7 - q_7)$$

where W_5 = Weight of steam bled at the fifth stage;
h_5 = Heat content of the steam bled at the fifth stage;
q_7 = Heat content of the liquid at the seventh-stage bleeding pressure.

From this equation the steam bled at the fifth stage is

$$X_5 = \frac{W_5}{W} = \frac{(q_5 - q_7) - X_3(q_3 - q_5)}{h_5 - q_5} =$$

$$\frac{(177.5 - 116.3) - 0.0717(243.8 - 177.5)}{1100.5 - 177.5}$$

$$= 0.0612 = 6.12 \text{ per cent of throttle flow.}$$

In a similar manner, remembering that the drip from both the third and the fifth heaters passes from the fifth heater to the seventh, the steam bled at the seventh stage is found to be 5.28 per cent of the throttle flow.

Increase in Steam Rate Due to Extraction

With a steam rate, when operating extracting and delivering 20,000 kw. of 12.84 lb. per kw.-hr., the total throttle flow is 20,000 × 12.84 = 256,800 lb. per hour. The steam bled from the third stage is 0.0717 × 256,800 = 18,310 lb. per hour. The steam bled from the fifth stage is 0.0612 × 256,800 = 15,700 lb. per hour. The steam bled from the seventh stage is 0.0528 × 256,800 = 13,560 lb. per hour.

The steam rate, straight condensing, can be estimated from the quantities thus far determined. With 18,310 lb. per hour bled from the third stage and an additional 680 lb. of steam required at the throttle for each 1,000 lb. bled, 18,310 × 0.68 = 12,450 lb. = reduction in the throttle flow if there is no bleeding at this stage. Similarly, a reduction of 7,160 and 3,100 respectively could be realized if there were no bleeding at the fifth and seventh stages. The throttle flow required to maintain the load of 20,000 kw. without bleeding is, then, 256,800 − (12,450 + 7,160 + 3,100) = 234,090. The corresponding steam rate is 11.7 per kw.-hr. The steam rate when bleeding is 9.7 per cent higher than this, over 18 per cent of the steam being extracted.

Combined Thermal Efficiency Increases in About Same Proportion as Steam Rate

Knowing the steam rates and the steam and feed-water conditions, the increase in the combined thermal efficiency due to the extraction can also be calculated. The combined thermal efficiency is

$$\frac{3{,}413}{S(h_T - q_f)}$$

where S = Steam rate in lb. per kw.-hr.;
h_T = Heat content of the steam at the throttle;
q_f = Heat content of the liquid leaving the condenser in case of operation non-bleeding, or leaving the last heater when operating bleeding.

When operating straight condensing with the feed water leaving the heater at 92 deg. F., the combined thermal efficiency is

$$\frac{3{,}413}{11.7(1{,}269.3 - 59.8)} = 0.241, \text{ or } 24.1 \text{ per cent.}$$

When operating bleeding with the feed water leaving the high-pressure heater at 274 deg. F., the combined thermal efficiency is

$$\frac{3{,}413}{12.84(1{,}269.3 - 243.8)} = 0.259, \text{ or } 25.9 \text{ per cent.}$$

The thermal efficiency is thus increased 7.5 per cent by operating extracting.

It should be carefully noted that this analysis applies specifically only when the turbine is delivering 20,000 kw. At reduced loads the bleeding pressures would be lower, with the result that the feed water would not be heated to as high a temperature.

Dry Air for Combustion?

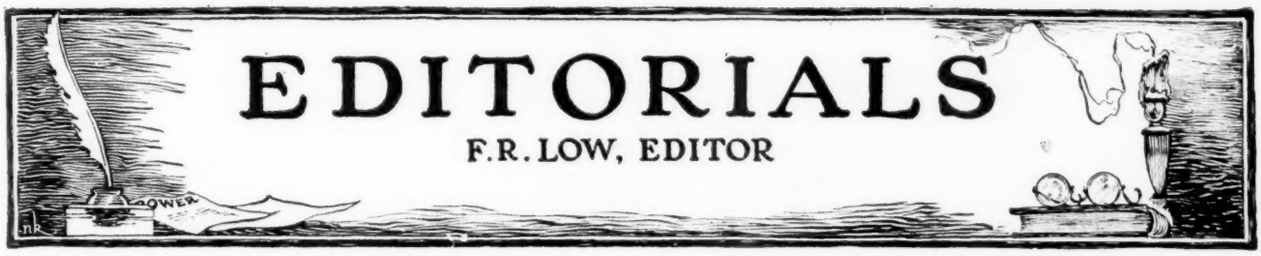
The *Metallurgist* (supplement to the *Engineer*, London) for December, 1926, suggests the use of silica gel for drying air for blast furnaces, pointing out that material savings in fuel are possible, not only through the elimination of the heat carried to waste by this moisture, but apparently also through improved combustion. Silica gel, it seems, is a powerful drying agent and is easily regenerated by heating, which can be repeated indefinitely without impairing the effectiveness of the material.

How about the boiler furnace? Will air drying pay? Offhand, it would appear not. Consider an extreme case. Air is supplied at 100 deg. F. with a relative humidity of 100 per cent. Each pound of air is accompanied by 0.042 lb. of water vapor. With 15 lb. of air per pound of coal, this is a burden of 0.63 lb. of vapor per pound of coal—somewhat more than that originating in the combustion of the hydrogen in the coal itself.

If this air-carried vapor could be eliminated magically, there would be a saving of perhaps 145 B.t.u. per pound of coal burned, or a little over 1 per cent of the heat supplied, based on an assumed exit gas temperature of 600 deg. F. But magic is impossible. If silica gel were used, it would ultimately become saturated. Then it must be replaced or regenerated. Replacement would obviously be too costly. Regeneration requires heat—just how much is a bit uncertain. If it were anything approaching the heat of vaporization of the moisture condensed in the gel, the regeneration process would require considerably more heat than was saved by abstracting this moisture from the air supply. Unless there were a marked improvement in combustion, air drying looks like a losing proposition.

The big heat loss due to moisture is that chargeable to the moisture from the combustion of the hydrogen content of the fuel. Since this moisture is condensed in the bomb calorimeter, it must be charged with its heat of vaporization, so that moisture from coal carries off perhaps 1,000 B.t.u. per pound, while that from the air, which enters as vapor and is simply superheated but not cooled all the way back to its initial temperature, will carry off only some 250 B.t.u. per pound. Further, the mass of moisture from the air is usually much less than that from the coal—the example cited is an extreme case. So eliminating it is ordinarily a matter of straining at a gnat and swallowing a camel.

Moreover, it appears from some studies of combustion that moisture, so far from interfering with good combustion, is positively essential to the complete combustion of the carbon monoxide formed in the first stage of the process. True, adequate moisture may come from the combustion of hydrogen from the coal, whose elimination is out of the question.



An Opportunity To Serve and Profit

DURING the last two years much rehabilitation in equipment and improvement in operating practice have been going on in the industrial plant field. Advantage has been taken of advance in steam pressures, involving high-pressure or bleeder turbines and a more economic use of exhaust for process. Powdered coal, modern stokers, air preheaters, water-cooled furnaces, steam accumulators and combustion control now form part of the picture.

The results have been most gratifying as to performance and savings effected, numerous accounts of which have appeared in *Power* during the last eighteen months. But there are many such plants whose stories of improvement remain to be told. Each provides an incentive to like accomplishment in some other plant.

It is with the thought of providing such a stimulus, through bringing to light further commendable accomplishments of this character, and at the same time making it worth while for authors to put forth their best efforts, that *Power* offers the substantial cash prizes announced on the contents page of this issue.

Watch next week's issue for conditions of the contest.

The Engineer in Civic Life

THE only way to have a place in any aspect of life is to be alive to that aspect of life. Much is said about the desirability of introducing the engineer into governmental affairs, but progress is slow largely because the engineer, for the most part, sits by and waits for somebody to dig him out and ask him to do something. Nobody does.

Some years ago the engineers of Detroit organized the Associated Technical Societies of Detroit, and one of their early meetings was a luncheon of their Council with a good majority of the Common Council of the city as invited guests, who listened to brief talks telling them about the technical men of the city, their organizations, their ability and their willingness to help. The city fathers went away with at least one addition to their equipment for guiding the destinies of the city, in the shape of a more accurate picture of what the engineer is and what he can do for his community. And they used it. The Detroit organization has an enviable record of service.

The engineers of St. Louis have done much the same thing, perhaps on a larger scale. Starting in 1924, and again in 1926, they held joint dinner meetings of the representative engineers of the city with the members of the State Legislature from the city and county. In 1925 they entertained the City Aldermen similarly.

Undertakings of this sort, handled with intelligence and courtesy, help to accomplish what many an orator says he longs for. Of course common sense must have a part in making up any such gathering. Engineers with special axes to grind must be kept out or at least kept in the silent background.

After all, this is a simple thing to do. Get together two or three dozen representative and public-spirited engineers. Call up a hotel or restaurant by telephone. Invite the guests. Talk sense. Nothing could be simpler.

This done, do not expect spectacular results. The most stable progress is made through the long, strong pull of steady effort. Repeat these joint meetings from time to time. Legislators are human. They forget. And they remember, too. Now and then the engineer will have his opportunity, and then comes the crucial test. Will he hit the ball? He will if he sees to it that the man at bat is the best man available for the task in hand. When opportunity comes, it is up to him. No man can ask for more.

What Does Pure Air Mean?

THERE is some confusion among engineers and machinists as to what is meant by pure air. To some this term implies oxygen, to others, ordinary atmospheric air. Lack of a mutual agreement as to what an order for pure air covered has led to near disasters.

Air is commonly used in the starting of internal-combustion engines. In oil engines this starting air is admitted to part or all of the cylinders until the flywheel has acquired momentum, and as the fuel mechanisms of the several cylinders are brought successively into action, the air is progressively discontinued. Since the air from the starting and injection bottles is merely atmospheric air previously compressed to a high pressure and differs in no way from the air drawn into the cylinders through the intake valves, combustion occurs in normal fashion when the fuel-injection mechanism goes into action.

Although the fuel valve may well be likened to a blow-torch with air and fuel connections uniting into a common orifice, the amount of inert nitrogen in the air is sufficient to prevent the rate of combustion from assuming anything like a real blow-torch effect. If, however, oxygen be used, there is no mass of inert nitrogen to limit the temperature of combustion. That parts become so heated as to melt is not surprising. Of more consequence, the closer contact of the fuel with the necessary oxygen atoms permits the combustion to assume an explosion-like character. These are dangers to be avoided, and the obvious method is to avoid oxygen.

But here is the rub. If, after finishing the installation of an engine, the air bottles are found empty, frequently the mechanic or the engineer turns to a local welding supply house for a bottle. In instances where the engineer knows that air and not oxygen must be used, he is specific in ordering pure air, meaning ordinary air and not oxygen. The welder sends along a bottle of oxygen, for to him pure air is but a misnomer

for oxygen. In other cases oxygen is desired by the engineer in the mistaken idea that it will insure easy starting. Regardless of the intent, the first application of the oxygen sends part of the engine skyward.

These remarks have been provoked by an explosion on a tug at Mobile, Alabama, and by a somewhat similar trouble in a New York plant. In both cases oxygen was mistakenly used, to the great expense and injury of those interested.

In no case should air be obtained from a welding concern unless it be tested before use. The best procedure is to install a small gasoline-engine- or motor-driven compressor for recharging. Avoid pure air.

Turbine Guarantees with Bleeding

THERE seems to be a need among engineers for a clearer understanding of the effect of bleeding on the design and performance of steam turbines. Some recent installations of turbines with bleeder heaters have not produced the results expected of them. In certain cases the manufacturer has been at fault. In other cases the designing engineer has, often unintentionally, specified conditions that are not conducive to the highest efficiency.

The manufacturer frequently furnishes the purchaser with pressures and heat contents of the steam at the various bleeding points. Performance calculations are based on these figures, and heaters are purchased to conform with the stated conditions. When the turbine has been put into service, the actual pressures and heat contents have, in some cases, varied from those specified. With the data now available on all makes of large steam turbines, it should be possible for the designer to estimate accurately steam conditions at every point in the turbine both with and without bleeding. To furnish customers with data on steam conditions that are at wide variance with actual performance, therefore, seems inexcusable.

The customer, on the other hand, frequently wishes to test his turbine. This is often a difficult matter with bleeders, so he asks for guarantees of performance with no bleeding. The tendency of the manufacturer will naturally be toward a design that will give best performance under guaranteed conditions; that is, without bleeding. When this unit is bled, the normal steam conditions for which the machine was designed, are greatly disturbed.

If the same load is to be carried in each case, more steam must enter the first stages when bleeding than when non-bleeding. For instance, with 350 pounds, 700 degrees, 29 inches vacuum, and four-stage bleeding, about fifteen per cent more steam must enter the throttle when steam is bled than when no steam is bled at the same load. Also about twelve per cent less steam will pass to the condenser with bleeding than without. The normal condition of operation will be with the bleeders all in service. It will therefore be evident that maximum efficiency in daily operation requires quite different nozzle and blade proportions in both high- and low-pressure sections from a design for non-bleeding operation.

These considerations point to the definite conclusion that such turbines should be purchased, guaranteed and designed for best operation when bleeding, as in daily service. The customer should indicate to the manufacturer the heating service to be furnished by the bleeder heaters. This generally consists of heating condensate plus a certain percentage of makeup to a given temperature. The designer can estimate the steam to be bled and can proportion each stage for the service conditions it must meet. The customer should include the necessary provisions in his design to permit tests to be made in bleeding service, or the manufacturer may guarantee an over-all B.t.u. per kilowatt-hour performance.

Turbines purchased on such a basis will give more satisfactory service performance than those designed for non-bleeding but with bleeder attachments added.

A "Sketch Map" of Heat-Insulation Data

IN VIEW of the existing confusion regarding the fundamentals of heat transfer as applied to insulating materials, L. B. McMillan rendered a real service to the engineering profession by outlining the present state of knowledge in this field at the recent annual meeting of the A.S.M.E. While space limitations make it impracticable to reproduce his entire paper, certain portions of particular interest to readers are covered by the abstract on page 180 of this issue.

The author approaches the subject from the viewpoint of an engineer who has for years been applying basic scientific knowledge to the solution of practical heat-insulation problems and desires to show others how they likewise may base their practical work on fundamentals rather than on untrustworthy rules of thumb.

The chaotic state of existing literature and data on heat insulation is due in large measure to the lack of such writers to bridge the gap between the scientist and the engineer—to supply to the busy practitioner what Mr. McMillan has happily termed "sketch maps of engineering knowledge."

His paper falls in this class, and as such has a significance beyond that of the subject matter discussed. Engineers are busy men, and while their training fortunately gives them the ability to dig out from the storehouse of knowledge the facts they require and to sift the wheat from the chaff, yet they appreciate the saving in valuable time resulting from such presentations.

Rule of Thumb Is Passing

MANY signs mark the passing of engineering by rule of thumb. Science is progressing at an astounding rate; the body of fundamental data grows month by month and year by year. Sooner or later it is incorporated in advanced engineering practice, and another domain is lost to rule of thumb.

This trend has already been recognized in technical education. The better engineering colleges are straining every nerve to ground their students in the scientific fundamentals, realizing that no other equipment will enable them to meet the unknown problems of tomorrow.

The time is about here when ability to keep up steam pressure on a boiler and set the valves on a Corliss will no longer suffice to insure an engineer a good job. There is a steadily rising demand for more gray matter in plant operation—the ability to solve daily problems in the light of scientific and economic fundamentals.

To meet this demand, one must have all the old-fashioned mechanical "know how," plus the ability to marshal B.t.u. and dollars as a general directs his armies. There are such men, and they are carving big jobs for themselves.

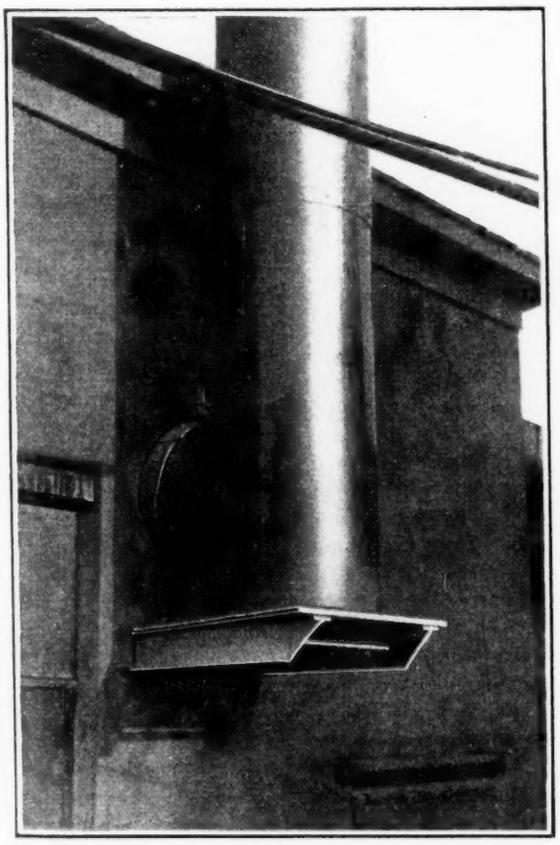
Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

A Practical Overhead Stack Foundation

In the construction of a new boiler house for a small plant the matter of dodging telegraph wires was one of the details that had to be arranged. The building was put up in such a way that one of the walls served also as one side of a coal pocket underneath the tracks of the railroad siding, and it happened that the poles of the railroad carried some forty telegraph wires over the siding at this point.

It was not advisable, therefore, to erect the stack directly over the boiler, which was of the locomotive type placed parallel to the tracks. And so, to prevent any possible trouble from swaying wires or damage from



Stack supported on beams placed in building wall

heat, as well as to make it easier to erect, the stack was placed outside of the building on the side farthest from the tracks.

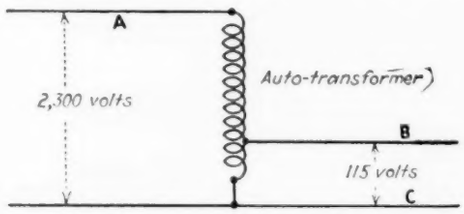
The illustration shows how the stack was supported. Instead of putting in a foundation and building up from that, with some 12 ft. of dead end before the flue joined, the stack was supported on the cantilever ends of two 6-in. I-beams, which were placed in the walls as the forms were filled and leveled at the correct height.

Over the projecting ends a ⅜-in. plate was laid and the beams were still further secured by a tie rod and spacer. The construction is neat, simple and cheap and leaves the ground space free of incumbrances right up to the building wall. The stack was 18 in. in diameter and weighed 1,600 pounds. D. A. HAMPSON.

Middletown, N. Y.

Hazards in the Use of Auto-Transformers

Auto-transformers have come into extensive use for voltage changes on alternating-current circuits where the ratio of change is small, but they should never be used to supply a lighting circuit unless as a balancing



Auto-transformer connected to obtain 115 volts from a 2,300-volt supply

transformer to obtain a 115- and 230-volt three-wire circuit from a two-wire 230-volt line. One of the approved applications is for starting motors, to supply 60 to 80 per cent line volts at the motor terminals at starting. This is the most extensive use of auto-transformers. Another application is to step the voltage of a generator up to double normal such as from 11,000 to 22,000 volts.

In these applications the difference in the primary and secondary volts does not change the hazard of a serious shock. For example, the difference between 460 and 350, or 2,300 and 1,600 volts, is not sufficient to remove the hazard to life in either case. If an auto-transformer is used to obtain 115 volts from a 2,300-volt circuit, as in the figure, then a very dangerous condition has been created, as the 115-volt circuit is in electrical contact with the high voltage. With a ground on line *A* it is possible for a person touching lines *B* or C to obtain practically a 2,300-volt shock.

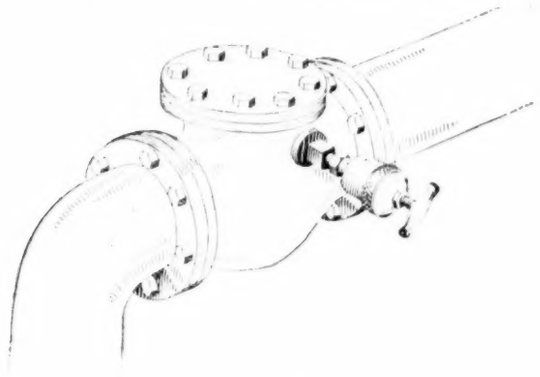
I know of one instance in which the auto-transformer system of distribution caused a death. This happened in a Western mining town. The lights on a circuit were out and an electrician was detailed to locate and remedy the trouble. He found a wire on the ground that was attached to the lighting line, so he picked it up. That was the lasf wire he was to touch. One side of the auto-transformer supplying the line had become grounded, and a person standing upon a conductive ground and touching either of the 110-volt wires would receive practically all of the transformer primary voltage. ANTHONY J. CHRISTOPHER.

Baldwinsville, N. Y.

Eliminating Trouble on Check Valves Used on Salt Water Lines

As salt water is used for condensing purposes at our plant, we have had considerable trouble from rusting of the hinge joint on the check valves on the discharge lines, the rusting action causing the disks to stick in a partly open position.

As it is necessary for the checks to be shut tight when priming the pumps with the steam syphon, it was necessary every few weeks to remove the covers and inject kerosene or other rust-removing liquids, and then raise the disks up and down until they would swing easily in



Injecting grease into check-valve trunnions keeps valve operating freely

the bearings. This work took considerable time and was expensive.

The illustration shows how this trouble was avoided. As the construction of the checks was such that the pins swung in trunnion nuts, a hole was drilled and tapped in the trunnion nuts for a ¼-in. pipe thread, then a compression grease cup was put on each valve, and by forcing in about a half cup of grease once a week, the checks were kept in good order.

New Bedford, Mass. R. G. SPOONER.

Getting the Best Out of Our Co-Workers

One of the great problems of today in the utility business is to arouse interest among the men who keep the plant in operation—to make the man like his job.

The commercial department meets the customers, and it has learned how to sell its point of view to the people whose money supports the business. On the other hand, the rank and file who operate and maintain the plant equipment have been more or less neglected.

Many companies have tried welfare among their employees. Has it been appreciated? In many cases I think not. Welfare is a hard thing to handle without spoiling those it was designed for. Several instances in my own experience will bear this out.

During the World War when anthracite was hard to get and its cost nearly out of the reach of the workingman, our firm purchased a car of hard coal for the men. The car was sidetracked at the plant and the coal loaded into trucks, in which it was weighed at one of the local coal yards. The employees got the coal at cost, which was several dollars per ton below the prevailing town price. Naturally, the local dealers did not relish this kind of competition. Here is what happened: When the weights of the coal delivered to the men were checked against the net weight of the coal in the car, there was a shortage of several tons. On investigation it was learned that some of the help were in the habit of coming out at night with autos and carting home what they could carry. This ended the buying of fuel for the employees.

Some time later another plan was tried for helping the men reduce the high cost of living. A company store was started. Only the company's employees were supposed to purchase at this place of business and not during working hours. What was the result? It was not long before men, who should have been working, were found loafing in the store. Some others bought goods at the reduced prices and resold them at a profit to their neighbors. Since some of the company's largest stockholders were in the mercantile line, they did not view with favor this kind of competition. Thus ended the store.

A final illustration. Some years ago it was the company's policy to supply the employees with free current for their homes. This favor was not appreciated by everyone. Passing by the homes of some of the men at any hour of the night, one could observe lights burning in cellars and attics. It was a little trouble to shut them off, but as it did not cost anything, they were allowed to burn. To remedy this condition it was decided to charge a small rate for the current. It seems to prove the saying that something for nothing is rarely appreciated.

And so these forms of welfare went by the board as a complete failure. Now for the other side of the picture.

You may call it welfare or any other name, but there is one kind of employee assistance that is usually appreciated. That is full pay while the employee is incapacitated from illness or injury. Of course employer liability insurance will take care of injury in the line of duty. Rarely does it allow the injured one full pay for the entire period of his disability. In the case of sickness, liability insurance, as usually carried, does not provide any compensation for the employee or his family.

The company that employs the writer makes it a practice to pay its men full time as long as they are laid up. The one string to this provision is that the attending physician must certify, in writing, that the patient was not able to perform any manual or clerical work during the period he was away. Our company has found, on investigation, that this treatment is valued by the men and their families.

Another means of creating good relations with the men is annual vacations with pay. This corporation allows all of its co-workers, from the highest to the lowest, eighteen working days off each year with pay. As an illustration of the opposite policy the writer calls to mind an experience of several years ago. He was in charge of a power station where only the office help and the operating officials were given annual vacations at the company's expense. It used to rile him to see some $15 a week clerk get his two weeks in summer, while he and his men stood the heat of the boiler room. The men never complained because they had never known any other kind of treatment.

What is the solution? Is it better to give the men every privilege and carry them along when they need it, or put it all in the pay envelope?

Binghamton, N. Y. C. W. REYNOLDS.

Comments from Readers

Elimination of Unburned Fuel Losses Increases Boiler Furnace Efficiency

The elimination of unburned fuel losses to further increase the boiler furnace efficiency of any powdered-coal fired unit depends on the reclaiming of carbon from the fly ash, from which source 1 to 3 per cent more heat from the fuel may be obtained.

Ash from pulverized-fuel furnaces is collected in quantities in various parts of the furnace, boiler, smoke flues, economizer, air heaters and chimneys, according to the design of such apparatus.

The quantity of this dust that may be collected is approximately 80 per cent of the total ash content of the fuel. It is distributed throughout the boiler and connection about as follows: 30 per cent in furnace; 10 to 15 in the second pass of the boiler; 15 to 20 in the smoke flues, economizer, etc.; 5 to 15 in the chimney base; 20 to 40 per cent in the dust collectors.

The carbon content of fly ash will vary according to the method of firing and the rates of combustion per unit of furnace volume. With good operation the percentages of carbon contained in the fly ash should be about as follows: ½ to 1 per cent carbon in the ash from the furnace; 10 to 35 per cent in the ash from the second pass and 35 per cent in the ash from the smoke flues, etc.

On the basis of 20 per cent carbon reclaimed from 50 per cent of the total ash in the coal, we will place at 10 per cent of the coal as received, each ton of coal (2,000 lb.) will then contain 200 lb. of ash and 50 per cent fly ash would contain 20 lb. of carbon.

Taking the calorific value of carbon as 14,500 B.t.u. and that of bituminous coal as 13,500 B.t.u., the fuel saved would be $\frac{14{,}500 \times 20}{13{,}500 \times 2{,}000} = 0.0107 =$ say 1 per cent.

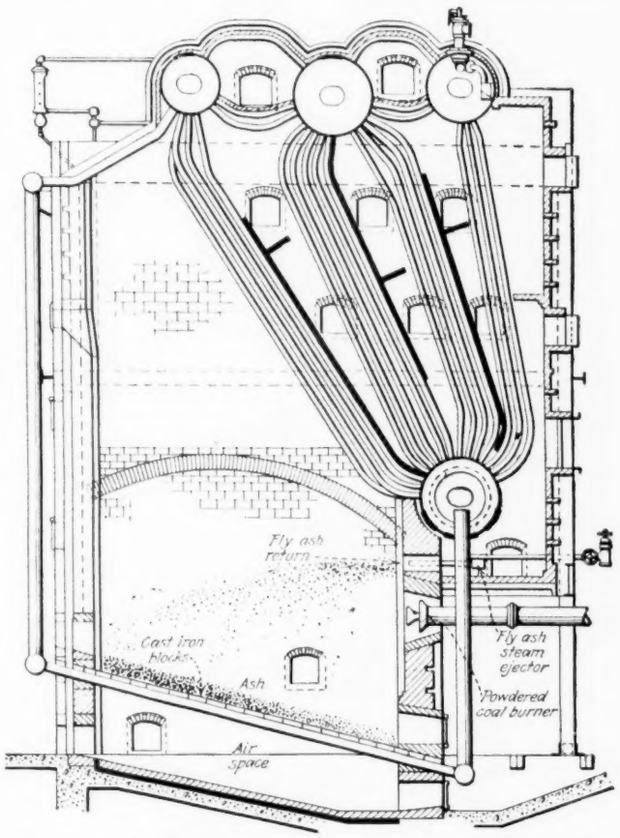
Thus with 20 per cent carbon in the fly ash the saving would be 1 per cent, with 40 per cent carbon 2 per cent and with 60 per cent carbon the saving would be 3 per cent.

The carbon in the fly ash may be returned to the combustion chamber by gravity or steam ejector, projecting the ash into the furnace from a high elevation, so as to let it fall slowly, or shower over the bottom. The illustration shows a water bottom furnace installed at the plant of the Hudson Motor Car Co., Detroit, for the burning out of any coal particles not burned while in suspension.

The large particles of carbon in the ash dropping on the furnace water bottom may continue to burn without any danger of slag or clinker formation. The water bottom is constructed of boiler tubes, on which 6x7-in. cast-iron blocks are placed with sufficient space at the joints to allow for growth or expansion, also to permit the infiltration of air, which will supply oxygen for burning out any carbon contained in the ash.

The trend of burning pulverized fuel is in the direction of short flame travel, which is one step nearer flameless combustion, which offers an opportunity for still higher efficiencies, with a less amount of water-heating surface.

The effect of ash in suspension on combustion is not generally known. Contrary to what is usually thought, the effect of certain surfaces (such as ash in suspension) in enormously accelerating the burning of fuel has been recognized for one century since Davy conducted his memorable researches, but with one or two minor exceptions, remained dormant until Doctor Bone took up the subject in 1902. It is now established that



Cross-section of boiler setting showing arrangement of fly-ash ejector and water bottom furnace

all solids have the power of inducing or accelerating combustion under suitable conditions.

That there is a steady increase in catalytic activity, with elevation of temperature, accelerating the combination of combustible gases, carbon with oxygen resulting in high calorific intensity. And since the surface of the solids or ash particles is in consequence raised to a high temperature, the great radiant energy which the hot surface possesses gives a large increment of heat effect.

Boiler trials conducted at the Mines de Blanzy, France, indicates that ash particles in suspension have a beneficial effect on combustion, when pulverized fuel is burned by the short flame travel.

The results of trials burning powdered anthracite of

no commercial value containing 30 to 40 per cent ash, firing a new 2,350-sq.ft. horizontal water-tube boiler, during a test of 48 hours, showed 3½ lb. of water evaporated per square foot per hour with a thermal efficiency of 84 to 85 per cent.

The boiler was in a steel building, with roof but no side walls, and the temperature of the air averaged about 25 deg. F. Under these conditions the radiation losses would be high. The trials showed exceptionally good boiler performance.

The water bottom furnace, as shown in the illustration, permits the burning out of the carbon in the ash, without slag formation, and increases the boiler capacity and efficiency and also tends to eliminate the difficulties caused by poor pulverization.

The reclaiming of some unburned fuel, a partial realization of the principles of flameless combustion, together with proper furnace construction, assure more steam capacity and higher thermal efficiency for standard boilers and superheaters. J. GOULD COUTANT.

New York City.

The Assistant Engineer—What Can He Do?

A few days ago a brother engineer called on me, and after I had listened to his tale of woe without being able to offer a solution to his trouble, he remarked: "Well, Terry, you are fond of writing; just put it up to *Power* readers. Perhaps someone will solve the puzzle, or some reader may find sympathy in knowing he is not the only man worrying about dead men's shoes."

Soon after the war this friend obtained a position as assistant engineer to a large textile concern in England, the appointment having in view the promotion to chief engineer and a salary not obtainable elsewhere in that locality.

The old chief, being over 70 years of age and having completed fifty years with the firm, was supposed to retire practically, but the managing director, in making the appointment, while putting stress upon the improved position in view, made it plain when my friend suggested a time limit, that old "Andy" would be chief as long as he liked to come about the place and have the last word about everything connected with the plant.

On taking up this position, my friend soon found that the director's views about retirement were not shared by the old chief and there would be little scope for him beyond carrying out orders, but he consoled himself with the thought that it wouldn't last long, and moved into a larger house and incurred other expenses upon his family whose future he desired to promote. This happened over six years ago, and old Andy is still on the job, and my friend seems as far off as ever of realizing his ambition. After persistent efforts he obtained a small increase of salary, but the directors made so much of the fact that some day he would get a real salary that he is dubious about approaching them again.

At his work he is handicapped at every turn. He is anxious to make improvements in his plant and could make great savings, but when he approaches the directors, he is told that the matter will be placed before the old chief and he rarely hears anything further. But he is quite sure that with old "Andy" out of the way he would have a fairly free hand and every support from the directors. Naturally, his future prospects are marred by the thought of waiting upon someone's death before realization, and he is quite sure that should he resign and the old chief die the next day, he would never be taken on again.

In cases of this sort it is difficult for one to advise. It is quite evident sentiment and not business plays the important part with this firm. My own personal view (and I would like the views of others) is that my friend must just "thole" it or get right away from the district. On the other hand, the firm might be induced to change their present attitude or old Andy might withdraw somewhat or, by an act of magnanimity on his part, exchange salaries or make a division. Can any of these things be brought about?

Belfast, Ireland. F. P. TERRY.

Why Is the Vacuum Low?

In the inquiry of A. W. Napier in the Nov. 16, 1926, issue sufficient details of the equipment are not given in order to diagnose the trouble thoroughly.

First, we should know the altitude at Stone, Kentucky, in order to figure how far below the actual barometric reading this equipment is operating. The vacuum, according to the figures submitted, does not follow any fixed set of load changes, but does follow closely the temperatures corresponding to that vacuum. The type of air pump used has a lot to do with the vacuum maintained, and if this installation uses a hurling water pit with 118- or even 100-deg. water, the results they are obtaining are good, as this type of pump requires fairly low temperature water at all times. From the general information given, the superheat is unknown and one can only guess what kind of turbine is being operated. The inlet-steam pressure given would indicate that it is a single-flow reaction turbine, and if that is the case the blading may be so dirty that the steam consumption is excessive, as 18-deg. rise on circulating water in a 4,000-sq.ft. condenser with half load is unusually high. If the machine is the old type impulse four-stage machine, the trouble is likely to be in the carbon packing, or possibly the buckets of the first-stage wheel are plugged or the overload valves are partly open bypassing first-stage steam to the lower stages.

Assuming a steam consumption of 25 or even 30 lb. per kw.-hr. with a 17-in. vacuum is not too high, and at that rate the condenser is handling nearly as much steam as is required of it on 2,000-kw. load with 28-in. vacuum. If in good condition 18 to 20 lb. is more nearly what should be used per kilowatt-hour, so it can readily be seen that the pressure in the tube space is high because the vacuum is low.

I would suggest that Mr. Napier fill the steam side of the condenser and turbine with clear water up to the point where the water runs out along the turbine shaft, and he may find, as I have seen before, a crack in the lower flange of the copper expansion joint where it bolts onto the condenser inlet. He may find some of the nuts on the studs on the top flange have not been pulled up snug. There are many causes for low vacuum, and in spray-pond installations the old excuse, high temperature of circulating water, is always handy, but it cannot be applied in this case with only 18 deg. rise in the circulating water. The condensate temperatures are too

high by far, buf could not be otherwise with the low vacuum maintained.

If I were operating a plant with conditions such as outlined by Mr. Napier, I would shut down the unit Saturday night and get every man in the plant busy looking for leaks in valve and pipe connections, air lines, etc. If he happens to have one of the old-type three-stage vertical wet-vacuum pumps, he may find a lot of his trouble on the plunger-rod packing glands.

It is like looking for a needle in a haystack to help the other fellow without complete details as to what equipment he is operating. In my experience in chasing vacuum troubles, I have found everything from bird's nests in the atmospheric exhaust line to a blanket of leaves over the circulating-water intake rack. One of the first shutdowns of a serious nature I encountered, was on an old-type four-pass condenser connected to a 5,000-kw. two-stage vertical turbine, and with full load the vacuum started down and all our efforts could not stop it, so we shut down and took one head off the condenser to find nearly every tube plugged with a minnow.

I would be much pleased to hear further through *Power* where Mr. Napier finds his trouble, and if he does not find it in any of the places mentioned, if he will give more details of his equipment, I am confident some reader will quickly solve his trouble for him.

Chicago, Ill. CARL WILDEY.

The details given by Mr. Napier are somewhat vague, but from the readings given we can roughly calculate the work performed by the condenser. Referring to the 5 o'clock reading and assuming that the barometer reading is 30 in., the absolute pressure would be 15 in., which corresponds to a temperature of 180 deg., and the total heat of the steam entering the condenser at this temperature would be 1,138 B.t.u.

The condensate temperature is given as 190 deg., but it appears that there is an error either in this reading or in the vacuum reading. Assuming that the vacuum reading is correct, the condensate temperature should be around 176 deg. Now the heat extracted from each pound of steam by the condenser would be 1,138 — (176 — 32) = 994 B.t.u. As no figures are given for the quantity of steam used by the turbine, this can be estimated from the amount of circulating water and the temperature rise through the condenser.

Assuming the pump to be operating at full capacity, the amount per hour would be 3,600 × 60 × 8.34 = 1,800,840 lb. With a temperature rise through the condenser of 26 deg., the total heat carried away by the circulating water = 46,821,840 B.t.u.; then 46,832,840 divided by 994 equals 47,104 lb. of steam per hour, or 63 lb. per kw.-hr. This of course is an unreasonable figure. It would appear to me that the trouble is somewhere in the circulating-water system.

Since the pump is submerged, a compound pressure gage might be connected on the intake to the pump, at the pump, and if the intake is obstructed, the gage would show a partial vacuum at this point. It might be well to determine the difference, if any, between the actual speed of the pump and the full-load speed given on the nameplate, also to remove the cover and inspect the impeller. The spray nozzles appear to be partly clogged, as 15 lb. pressure at the nozzles is unusually high. D. S. SKILES.

Eastland, Texas.

Early Applications of Air Preheaters

Referring to the editorial in *Power* Dec. 14, 1926, it is stated that "preheaters have only recently become a recognized part of the modern power plant." While this is true so far as stationary power plants are concerned, it is no new thing when referring to boilers in steamships. As far back as 1886 or 1888 the S.S. "Ohio," of the American line, was refitted with boilers and engines by Howden, of Glasgow, Scotland, with his method of air preheating and forced draft.

This equipment consisted of a chamber built over the front connections of the Scotch marine boilers and forming a part of the uptake or breeching under the stack. Tubes through this chamber conveyed the gases to the stack, while the air to be heated was forced around their outside and then led to the closed ashpits and also to valves admitting air over the top of the fires.

Having no data at hand, I quote pressures and temperatures from memory only: Air pressure at fan discharge, 4½ to 5 in. of water; air pressure at chamber and ducts to ashpits, 2½ in.; air pressure at chamber in ashpits, 1¼ to 1⅜ in.; air pressure in furnace over fire, ⅜ to ½ in. The main tubes were fitted with retarders, strips of twisted sheet metal, which helped to maintain the pressure over the fires. The stack pyrometer registered approximately 500 deg. F. when preheating the air, and when, for any reason the fan was stopped and the boilers worked under natural draft, the stack temperatures would rise to 700 degrees.

If I remember correctly, the "City of Berlin," of the Red Star Line, was another ship that had its boilers fitted with air preheaters, but used induced instead of force draft.

The "Ohio," it seemed to me, was used as an experimental ship, previous to the building of the "New York" and "Paris." Mr. Doran, the company's chief engineer, at that time seemed willing to give a tryout to almost any proposition applicable to marine engineering with a view to its incorporation in the new ships, should it prove its value on the "Ohio." Weir's system of feed-water heating, one time illustrated in *Power*, was also installed in this ship. It was a forerunner of the bleeder methods now used.

The steam chest of the low-pressure cylinder, operating at an average pressure of 12 lb. per sq.in., was tapped and a portion of the steam led to the feed-water heater. There was also a connection from the auxiliaries which permitted these engines to exhaust into the feed-water heater or to the low-pressure cylinder, depending upon the amount of steam the feed water could condense.

The question in the editorial regarding cost of upkeep ought to be readily answered from the records of this and other ships fitted with the Howden system.

I do not recall that the repairs were unduly large, and such as they were, they were mostly on the air control valves, which the firemen usually operated with a blow of some fire tool rather than with their hands.

The Scotch marine boiler certainly had the water-cooled furnace. While new bridge walls were always built in port, they seldom lasted more than eight hours; and because of the fusing and clinkers that adhered to them, they were broken up and thrown out by the firemen. This ship, with its preheated-air power plant, produced an indicated horsepower on 1¼ lb. of Welsh or Pocahontas coal. Not so bad for forty years ago!

Washington, D. C. D. ALFRED MANSON.

Heat Transfer Through Insulation*

An Outline of the Present State of Knowledge on the Subject, Covering the Range from Moderate to High Temperatures

By L. B. McMILLAN†

IN THE paper that follows I have attempted to outline the existing knowledge on heat transfer through insulation in the moderate and high-temperature fields as set forth in the literature, pointing out in what respects this knowledge is insufficient and what further research is most urgently needed.

I have endeavored to prepare a "sketch map" of the subject on which the principal landmarks are so clearly marked that the user may find his way through the problems involved without becoming lost in a wilderness of detail.

We must have a meeting of minds on the part of scientists and engineers. With the scientists furnishing the fund of knowledge and fundamental laws and the wealth of detailed information, and the engineers contributing the knowledge of what constitutes a convenient, usable and practical presentation of the facts, excellent results are certain of accomplishment.

If this paper makes any considerable headway in clarifying the meaning and use of the term conductivity and in emphasizing the importance of a thorough understanding of surface resistance, it will have been worth the effort and more. The literature of heat transfer is expanding rapidly and it is essential that, if the current literature is to add anything of material value to the fund of knowledge on the subject, it must be based on a solid foundation of fundamental facts. It is useless to attack the more difficult problems without a clear understanding of these basic principles.

Definitions and Equations

The fundamental theory of heat transfer in the steady state (uniform temperature conditions maintained at both warmer and cooler surfaces) has been well known throughout the last century by the leading authorities on heat transfer. Briefly, it is based on the same conception as Ohm's law, that flow varies directly as the potential and inversely as the resistance.

Single Layer with Flat Surfaces

The resistance to heat transfer is dependent upon the thickness x and the conductivity k. It varies directly as the thickness and inversely as the conductivity and is equal to x/k. Therefore, the simplest case of heat transfer through a material having flat surfaces is represented by the equation,

$$U = \frac{t_1 - t_2}{\frac{x}{k}}$$

in which U is the over-all rate of heat transfer in B.t.u. per square foot per hour, t_1 is the temperature of the warmer surface and t_2 the temperature of the cooler surface.

Definition of Conductivity

Thermal conductivity is defined as rate of heat transfer in one direction (in a direction perpendicular to an area) per unit area, per unit temperature differential per unit thickness, per unit time (B.t.u. per square foot, per degree temperature difference between surfaces per inch of thickness, per hour).

Conductivity is a specific property of a material. It is not dependent on the area, thickness or shape of the material. It is the same for a 0.1-in. thickness of the material as it is for a 10-in. thickness. It is constant for a uniform material, whether the material is on a pipe or on a flat surface. It is a *rate*, not a *quantity*.

The total quantity of heat transmitted is dependent upon the area, shape and length of path (thickness of material), but conductivity is not. Conductivity is dependent upon temperature, but this is also true of other specific properties of a material, density for example.

Since conductivity is a function of temperature, the correct basis of expressing its value is in terms of conductivity at the mean temperature of the material. This mean temperature is the arithmetical mean of the temperatures of the two surfaces and is not the temperature at the physical center of the material.

One Material and One Surface Resistance—Flat Surface

Often the temperature of the cooler surface is not known, the known temperatures being that of the warmer surface, t_1, and that of the air surrounding the cooler surface, t_a.

Then the rate of heat transfer is given by the equation

$$U = \frac{t_1 - t_a}{\frac{x}{k} + \frac{1}{c}}$$

in which c is the rate of heat transfer from outer surface to air, in B.t.u. per square foot per hour per degree temperature difference between the outer surface and the air. The term $\frac{x}{k}$ represents the resistance of the material in question and the term $\frac{1}{c}$ represents the *surface resistance*.

The lack of thorough understanding of the effect of surface resistance is perhaps responsible for more confusion in the literature of heat transfer than any other single item. The failure to separate the effects of surface resistance from those of insulation resistance is the cause of most of the conflicting conceptions of conductivity.

In some cases surface resistance is the controlling factor in the total rate of heat transmission. For example, in the case of a quarter-inch thickness of a metal having a conductivity of 2,500 B.t.u. per square foot per degree temperature difference between surfaces per inch thickness per hour, and with a temperature difference of one degree Fahrenheit between surfaces, the rate of heat transfer per square foot, per hour would be

$$\frac{1}{\frac{0.25}{2{,}500}} = 10{,}000 \text{ } B.t.u.$$

If, however, the temperature difference between the warmer surface and still air surrounding the cooler surface is one degree Fahrenheit, and the rate of heat transfer from surface to air is 2.0 B.t.u. per square foot per degree temperature difference per hour, the total heat transfer per square foot per hour would be

$$\frac{1}{\frac{0.25}{2{,}500} + \frac{1}{2}} = \frac{1}{0.0001 + 0.5}$$

$$= 1.9996 \text{ B.t.u.}$$

(or, for all practical purposes, 2 B.t.u.)

In this case the surface resistance is 99.98 per cent of the total and the resistance of the metal is practically negligible. In such a case a variation of 100 per cent in the conductivity item would have no appreciable effect on the total.

One Material, Two Surface Resistances—Flat Surface

When the temperature of neither the inner nor the outer surface is known, and the known temperatures are those of the air on either side of the insulation, the equation for heat transfer is

$$U = \frac{t_a - t_a}{\frac{1}{c_1} + \frac{x}{k} + \frac{1}{c_2}}$$

in which t_a is the temperature of the air on the warmer side, c_1 is the rate of heat transfer from air to surface on the warmer side and c_2 is the rate of heat transfer from cooler surface to surrounding air.

The inside surface resistance $\frac{1}{c_1}$, is not used when the temperature of the warmer surface is known. Also, its magnitude is often negligible where effective insulation is placed directly against a heated surface the temperature of which is known. However, it is included in these general equations

*Digest of a paper presented at the Heat Transfer Session arranged by the National Research Council at the annual meeting of the A.S.M.E. (December, 1926), in joint session with the A.S.R.E.

†Chief engineer, Johns-Manville, Inc.

in order that it be not neglected in cases where it should be taken into account.

Two or More Materials—Flat Surface

So far, only one material has been considered. If heat must flow successively through two or more different materials, the equation takes the form

$$U = \frac{t_o - t_a}{\frac{1}{c_1} + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \frac{x_3}{k_3} + \ldots + \frac{1}{c_2}}$$

in which x_1 x_2, x_3, etc. are the thicknesses of the various materials and k_1, k_2, k_3, etc., are the conductivities of the respective materials.

Cylindrical Surfaces

Except on flat surfaces the internal resistance of a material does not vary directly as the thickness. In the case of cylindrical surfaces increasing the thickness supplies additional resistance through which the heat must flow, but at the same time increases area of the path. The path through a cylindrical layer steadily widens as one moves outward from the inner surface. It is therefore clearly apparent that the heat transfer per unit of area of inner surface will be greater for a given thickness of insulation on a curved than on a flat surface, and that the smaller the radius of curvature the greater will be the rate of heat transfer per unit of inner surface area.[2]

Effect of Air Velocity on Heat Transfer Through Insulation

In the case of well insulated surfaces the increases in heat losses due to air velocity are very small as compared to the increases for bare surfaces. This is due to the fact that air flowing over the surface of the insulation can increase only the rate of heat transfer from surface to air and cannot change the internal resistance to heat flow inherent in the insulation itself.

The effect of the air circulation, therefore, is to cool the surface of the insulation to a temperature lower than it would have under still-air conditions, thereby increasing the temperature drop through the insulation.

In the case of insulation located out of doors, the combined effect of wind and rain may bring the surface temperature of the insulation practically down to the air temperature, yet even in this extreme case the increase in heat loss through the insulation is not as great as might be expected.

The foregoing discussion as to the effect of air circulation on losses through insulation, is based on flow of air over the *surface* of the insulation, and applies only to cases where the insulation is tightly sealed. If the condition of the insulation is such that the air may circulate through cracks and crevices, the increases may easily be far greater than this. It is essential that all insulation be sealed as tightly as possible, particularly if it is located out of doors.

The lack of a simple means to measure approximately the amount of heat loss from surfaces has naturally led to a widespread feeling that the degree of effectiveness of insulation may be estimated by the surface temperature. Probably no other conception in connection with heat transfer is so generally misused as this one.

Surface temperature considered alone, without reference to temperature of surroundings, is *absolutely no measure of the rate of heat transfer.* A surface at 150 deg. F. in a confined space exposed to air at 150 deg. may

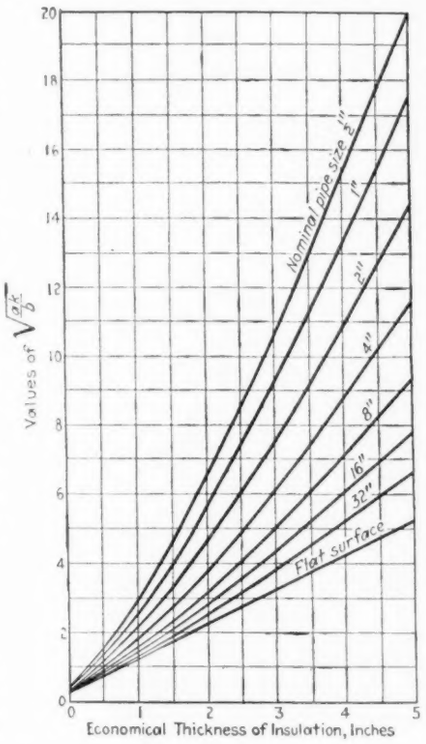


Chart for determining economical thickness of insulation from the computed value of $\sqrt{\frac{ak}{b}}$

be losing no heat at all, whereas a surface at 100 deg. exposed to air at a temperature of 50 deg. is losing heat in very considerable quantities.

Measuring the difference between the surface temperature and the air temperature is a little better, but not much, unless all other conditions are identical—which they rarely are. It is easily possible for the losses to vary over a range of several hundred per cent at the same temperature difference, depending on the air velocity to which the surface may be exposed. Nor is it necessary for that velocity to be very high in order to render both surface temperature and temperature difference (surface to air) entirely valueless as an indication of heat loss.

Perhaps the most valuable use for accurate data on heat transfer in connection with insulation is in the calculation of the thickness of insulation required under various conditions for most economical results.

For flat surfaces this may be determined from the equation in which x

$$x = \sqrt{\frac{ak}{b}} - Rk$$

is the most economical thickness, k the conductivity, b the cost of insulation in dollars per square foot *per inch thick per year.* R the sum of the resistance of all other elements in the construction, including surface resistance, and a constant obtained from the accompanying table.

Practically all manufacturers now sell heat insulation on the basis of a discount from the same standardized list prices. For flat surfaces this standard list price is 30c. per sq.ft. one inch thick. For sectional insulation the same value may be used in connection with this equation without introducing any error of practical importance. Therefore for either form of insulation b may be figured by applying to $0.30 the discount at which the insulation is purchased and then multiplying this net by the decimal representing fixed charges (interest, depreciation, etc.). For example, if the discount is 55 per cent and fixed charges are 20 per cent, b would be ($0.30 × 0.45) × 0.20 = $0.027.

Having worked out the value of $\sqrt{\frac{ak}{b}}$ one can read the most economical thickness directly from the accompanying diagram.

Further Investigation Needed

It is highly probable that with the mass of scientific data available on various phases of the subject, the combined efforts of a group of scientists and engineers could be depended upon to iron out existing contradictions and discrepancies and put the state of knowledge of heat transfer from surfaces to air in very satisfactory shape with a minimum of actual laboratory work.

There is an obvious need for such further investigations dealing with fundamentals. In addition to the effects of air velocity, the effects of shape, extent, position and nature of the surface on the rate of heat transfer should be investigated and the results put in a form for convenient use.

VALUES OF "a" FOR CONTINUOUS OPERATION

Temp. Diff.	Value of Heat in Dollars per Million Available B.t.u.									
Deg. F	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
100	0.088	0.175	0.236	0.350	0.438	0.526	0.613	0.701	0.788	0.876
200	0.175	0.350	0.526	0.701	0.876	1.051	1.226	1.402	1.577	1.752
300	0.263	0.526	0.788	1.051	1.314	1.577	1.840	2.102	2.365	2.628
400	0.350	0.701	1.051	1.402	1.752	2.102	2.453	2.803	3.154	3.504
500	0.438	0.876	1.314	1.752	2.190	2.628	3.066	3.504	3.942	4.380
600	0.526	1.051	1.577	2.102	2.628	3.154	3.679	4.205	4.730	5.256
700	0.613	1.226	1.840	2.453	3.066	3.679	4.292	4.906	5.519	6.132
800	0.701	1.402	2.102	2.803	3.504	4.205	4.906	5.606	6.307	7.008
900	0.788	1.577	2.365	3.154	3.942	4.730	5.519	6.307	7.096	7.884
1,000	0.876	1.752	2.628	3.504	4.380	5.256	6.132	7.008	7.884	8.760

[2]The original paper gave equations for cylindrical surfaces applying to the same cases of heat transfer as those worked out for flat surfaces

Recent Publications

Mechanical World Year Book, 1927. Emmott & Co., Ltd., Manchester. Cloth; 4¼x6¼ in.; 348 pages of text, 170 pages of advertising; with a diary and memorandum book for the year. Price, 1s. 6d.

The fortieth edition of this handbook for the practical engineer or machinist contains much new material on such subjects as rails and wheels, belt conveyors, toothed gearing, condensers, etc. It naturally reflects British practice and will doubtless not prove particularly useful to the worker in American shops.

St. Lawrence River Ship Canal. Compiled by Julia E. Johnsen. Published by The H. W. Wilson Co., 958 University Ave., New York City, 1926. Cloth; 5x7½ in.; 129 pages. Price, 90 cents.

Few projects have attracted the public attention that the development of the St. Lawrence River for power and navigation has. This is attested by a bibliography in this little book that lists 160 articles, books, pamphlets, documents and speeches that have been published since the Joint Engineering Board made its report on this project in 1922. There is also included a brief giving the affirmative and negative sides of the question, as well as a number of articles for and against the project. This volume supplements the book published in 1922 giving a digest of the two sides of the development up to that time. For those who are interested in studying the development of the St. Lawrence, this little book gives much valuable information, and the bibliagraphies form a handy reference to the literature that is available on the subject.

"The Oxwelder's Manual"—Instructions for Welding and Cutting by the Oxy-acetylene Process. Ninth edition, completely rewritten. Published by the Oxweld Acetylene Company, Long Island City, (New York) Chicago, San Francisco, 1926. Cloth, 6x9 in.; 216 pages; numerous tables, photographs and diagrams. Price, $1.

If the phenomenal growth of the welding industry is to be along sound lines, it is essential that the men who carry out the actual operation understand fully what they are doing. There is, therefore, a great field for books designed specifically for welding mechanics or others who may occasionally take the torch in hand to do a job of welding. Such books must be, above all things, practical. The "Oxwelders Manual" meets this test. It is particularly to be commended for its clearness and simplicity. While presented as a ninth edition, it is in reality a new book, having been rewritten entirely to take account of the latest advances in welding progress.

Specific instructions are given for cutting (including the cutting of heavy steel and cast-iron sections), for "stelliting," bronze welding of cast-iron and malleable iron and for welding of the following materials: Sheet steel, steel plate, steel pipe, cast steel, cast-iron, large gray-iron castings, brass and bronze, Monel sheets and castings, sheet aluminum, cast aluminum, high-carbon steel and alloy steel.

Clerical Salaries in the United States.—A comprehensive survey of clerical salaries of both men and women in the United States giving numerous tables on rates of pay of various types of employees. By National Industrial Conference Board, New York. Cloth; 6x9 in.; 60 pages. Price $1.50.

While wage statistics for the United States have been available in fairly compresensive form for about a decade, comparatively little statistical attention has heretofore been give to the salaries paid office workers. Wages of factory and other industrial workers had presented the more urgent problem; moreover, data on office workers' salaries were found extremely difficult to ascertain. The National Industrial Conference Board's report on "Clerical Salaries in the United States, 1926," recently published, therefore, may well be characterized as the first attempt at a broad survey of office workers' salaries for the country as a whole, in different lines of business and differentiating between male and female workers, the uniform disparity between men and women office workers' earnings making the latter distinction a factor of considerable importance in such an industrial inquiry.

The study covers the range of salaries paid to both men and women employees in each of twenty specific types of office work, selected so as practically to cover the entire field of office work. It presents the amount of salary most frequently paid for each type of work, as well as the percentage of workers receiving above and below the "model" average.

The data were gathered in eighteen large cities in different sections of the country.

Employment Statistics for the United States.—A plan for their national collection, and a handbook of methods recommended by the Committee on Governmental Labor Statistics of the American Statistical Association. It presents the consensus of opinion of the members of the Committee on Governmental Labor Statistics concerning problems involved in the collection and publication of adequate employment statistics for the United States. By Ralph C. Hurlin, of Russell Sage Foundation, and William A. Berridge, of Brown University. Cloth, 6x9¼ in.; 215 pages. Price, $2.50.

Bearing a warning to American industry that a business slump and widespread unemployment following a protracted period of prosperity (such as the present) can be avoided only by careful management and through accurate current knowledge of industrial conditions, the 200-page report on "Employment Statistics for the United States," just issued by the Russell Sage Foundation in co-operation with the American Statistical Association, presents a comprehensive plan whereby not only the major industries, such as manufacturing, mining, transportation, communication and agriculture, but industry and commerce in general may be furnished with a guide toward the prevention of over-production and over-extension of credit, the principal causes of business slumps and extensive unemployment.

Detailed knowledge of the trend of unemployment is at the base of the plan, which calls for the co-operation of federal, state and other governmental agencies with such industries as iron and steel, automotive, textiles, chemicals, paper, lumbering, construction and merchandising. The report is also in the nature of a handbook of methods for the collection and maintenance of employment statistics recommended by the Statistical Association's Committee on Governmental Labor Statistics. The report was prepared by Ralph G. Hurlin, director, Department of Statistics, Russell Sage Foundation, and William A. Berridge, associate professor of economics at Brown University.

Declaring that the volume of employment invariably reflects the condition of business, the report quotes the statement of Secretary of Commerce Herbert Hoover that "As the slumps in business are in the main due to the wastes, extravagance, speculation, inflation, over-expansion and inefficiency in production developed during the booms, the strategic point of attack, therefore, is the reduction of these evils, mainly through the provision for such current economic information as will show the signs of danger and its more general understanding and use by producers, distributors and banks, inducing more constructive and safer policies."

For the manager of an industrial company the proposed statistics would make possible comparison of his own plant with others in his industry; they would give him an index of activity in the industries from which he buys, and in those businesses to which he sells, and some knowledge of the purchasing power of the ultimate consumer. The manager would then, the report says, "be enabled to develop enlightened policies in regard to employment in his own labor force."

Elevator Specifications for the use of architects and engineers has been issued by the Warner Elevator Manufacturing Co., Cincinnati, Ohio. Copies may be obtained by writing to that company. An attempt has been made, not only to give a general specification, but also to show the limitations between which one may go and still remain within the requirements of good practice. With the aid of these 12 pages of general specifications, the architect or engineer should be in a position to prepare his own specifications for almost any passenger or freight elevator, or they may be used as a guide in checking up on other specifications.

News in the Field of Power

Congress Gets New Muscle Shoals Bid of American Cyanamid Company

Madden Bill Presents Offer To Take Fifty-year Lease with Fertilizer Production as Principal Function Dam No. 3 to Cost $32,500,000

ON THE eve of hearings by the House Military Committee on bids for Muscle Shoals, Congress, Jan. 24, received a bill embodying a new offer by the American Cyanamid Co., of New York.

The measure, sponsored by Representative Madden, Republican, Illinois, would provide for a fifty-year lease of the property of the Air Nitrates Corp., a subsidiary to be created by the American Cyanamid Co.

Four per cent interest on the government's expenditures since May 31, 1922, would be paid, and it is estimated that this would amortize, if continued 100 years, its entire investment.

Cyanamid Stipulations

The bid provides for government construction of Dam No. 3 at a cost of $32,500,000, and also for construction of Cove Creek Dam at a cost of $25,000,000 either by the government or the corporation. Fertilizer production would be the prime function of the corporation, with provision for government manufacture of nitrates in time of war. The fertilizer would be sold under supervision of a farm board to be appointed by the President with Senate approval from the membership of principal farm organizations.

Production would be on a scale of 10,000 tons of nitrogen and 40,000 tons of fertilizer plant food for the first two years, and would be increased gradually to a maximum of 48,000 tons of nitrogen, dependent upon whether the government or the corporation constructs the Cove Creek Dam.

Bid Spells Further Delay

Action on Muscle Shoals at this session of Congress has been made more remote, in the opinion of many members, by the action of reopening the consideration of Muscle Shoals legislation before disposing of the Muscle Shoals bill on the House calendar.

While the purpose of the committee in instituting new hearings was to consider the revised offer of the American Cyanamid Co., it was in no position to bar testimony on behalf of the so-called Slemp offer. As this is written, most of the time of the committee has been taken up in hearing statements in support of that offer.

The committee apparently is divided more or less evenly as to the advisability of reporting out further Muscle Shoals legislation. A delegation composed of representative officials and citizens of Tennessee is to be heard in opposition to the revised Cyanamid bill. There is strong opposition in Tennessee against a government dam at Cove Creek. This would deprive the state of taxable values and of the exercise of control over the development.

Madden Compares Ford Offer

"The offer of the American Cyanamid Co., as set forth in the bill I have introduced, is a better proposal than Henry Ford's," declared Representative Madden. "The original offer of the Cyanamid Co. provided for the production of fertilizers containing 40,000 tons of fixed nitrogen, the same as Mr. Ford's offer, but under my bill the American Cyanamid Co. agrees to produce fertilizers annually containing not less than 48,000 tons of fixed nitrogen, an increase of 20 per cent over the Ford offer; and this increase is equal to more than half of the fixed nitrogen contained in Chilean nitrates we imported in the year 1914.

To Use Present Plant

"A single comparison between the Cyanamid offer and the proposal of the Associated Power Companies seems to me sufficient. The power companies propose to build a new nitrate plant at an estimated cost of from 15 to 20 million dollars. The farmers must pay interest on this at the rate of about a million dollars a year and depreciation charges of about another million annually. In all the long record I know of nothing to indicate that by adopting a new process involving additional charges of $2,000,000 a year we will thereby be able to produce fertilizers more cheaply than by the use of our present plant. The farmers contend that Congress should not accept any offer that will unnecessarily add $2,000,000 a year to their fertilizer bills at Muscle Shoals, and in my judgment the farmers are right."

Sherman Power Plant Opens —Cost Put at $1,000,000

The completion of the new No. 6 hydro-electric power plant of the New England Power Co. at Sherman, a few miles south of Readsboro, Vt., was announced recently, the project having been under construction for a year and a half. Officials of the company were present at the opening and passed some time in a careful inspection of the plant.

The power station includes a 9,500-hp. unit with a powerful generator. An electric current of 2,300 volts is automatically controlled from the Davis Bridge station of the company, 2½ miles away. The Sherman station cost the company $1,000,000 it is reported.

Governor Smith's Water Power Bills Introduced

The drive for Governor Smith's water-power authority proposal was started Jan. 24 by Senator Bernard Downing and Assemblyman Maurice Bloch, who introduced identical bills in the Senate and Assembly, which, while they faithfully follow all the Governor's recommendations, show every disposition to compromise.

Without pledging the credit of the state, the bill gives the power authority the right to develop the state's water resources and preserve its perpetual ownership, without exercising its authority until a thorough study has been made, on which it must submit a report to the Legislature by Jan. 1, 1928.

The commissioners are required to confer with the Federal Power Commission, the International Joint Commission of the United States and Canada, the government of Canada and the governments of the Canadian provinces claiming control of water-power resources adjoining those of the State of New York.

Senate to Confirm Board

The authority is to consist of three members to be appointed by the Governor, by and with the consent of the Senate. One is to be appointed for seven years, another for five years and the third for three years. Their successors are to be named for five-year terms each. All are to serve without salary, although their expenses are to be paid.

The bills, which carry an appropriation of $250,000, direct the power authority commissioners to secure the best impartial engineering, banking and legal skill attainable and give them the power of subpœna to summon witnesses at any hearings they may hold during their investigation.

The authority commissioners are instructed to make an exhaustive study of the state's available water power resources, the horsepower which may be developed therefrom and its estimated demand from consumers, either now or in the future, the cost of development, the estimated capital expenditures required for dams, power houses, transmission lines and the most available agencies for the distribution of power throughout the state.

Will Study Finance Plans

They are particularly charged with ascertaining the rates of interest at which the power authority may secure the funds for development. Suitable provisions are to be recommended as to how interest on borrowed capital may

be paid and amortized over a period of time. Suggestions also are required for safeguarding investors.

The commissioners also are instructed to make a thorough study of prices power companies can reasonably make for furnishing light, heat and power to consumers and estimate schedules for household, industrial, agricultural and municipal uses.

The final injunction of the two bills calls for the commissioners' recommendations concerning the economical practicability of operating under continuation of the power authority.

N.A.S.E. Plans for Convention and Exhibit Point to Success

Steady progress is being made in arrangements for the success of the forty-fifth annual convention of the National Association of Stationary Engineers, which will be held at the Hotel Ambassador, Los Angeles, Calif., during the week of Aug. 22-27, inclusive.

In conjunction with this year's convention will take place the Pacific Coast Power and Mechanical Exhibit, conducted by the National Exhibitors' Association. Backing this joint undertaking is the active co-operation of the entire association as well as strong assistance and support from many other sources, reports Fred J. Fischer, chairman of the convention committee, in reference to the enthusiastic reception of the plan manifest on all sides.

The members of California No. 2, of Los Angeles, are already at work on details of the meeting with the aim that this year's gathering shall prove the largest and most successful held heretofore.

Chairmen Appointed

National President John Q. Adams has appointed the following chairmen for the various committees: F. J. Fischer, chairman, H. R. Hilton, vice-chairman, John Topham, secretary, T. R. Harlihy, treasurer, convention committee; J. P. Buller, hotels; H. G. Smock, programs; O. D. Spray, entertainment; B. C. Parker, speakers; C. T. Bailie, decorating; W. D. Campbell, publicity; Guy L. Warden, transfer; H. G. Knapp, auto transfer; W. T. W. Curl, transportation; T. S. Simpson, superintendent of power; and L. C. Brown, printing.

Local President Brown has appointed a like number to assist those appointed by the National president, as follows: J. R. Moore, George Baymiller, Fred Lewis, George Mikkelson, A. L. Buzzell, Sid Griffin, Robert Walters, E. M. Dixon, L. E. Phipps, Fred Robb, George Buell, Roy Baker, E. Williams, Arthur Beckwith, and John Rafferty.

At this early date the committees have arranged for a number of features that are different from those of previous conventions.

Ponca City, Okla., To Extend Municipal Power Plant

A bond issue of $300,000 to cover an extension to the municipal light plant, has been voted by Ponca City, Oklahoma. The plant is at present operated by a combination of Diesel and steam engines, and it is planned to install two more oil engines. It is the intention to move the plant to a new site, erect a cooling tower and install pumps for the water works.

The present Diesel plant has been in existence five years, and in this $550,000 has been earned with rates comparable with those in other Oklahoma cities. So successful has been the plant's record that for three years in succession there has been no general municipal tax here, although the city has provided many additional facilities, far in advance annually of the amount of money which the law provides could be raised by a general tax. It is simply the result of putting the municipal plant on a business basis, the same plan as would be adopted for any industry or by any privately owned public utility.

Ponca City has approximately 20,000 population, yet the only city tax is one to form a sinking fund to pay off bonded indebtedness.

Although several offers have been received to buy the municipal plant, all of these have been turned down decisively, notwithstanding the fact that an offer of $1,000,000 has been reported.

The special Chamber of Commerce committee, named to investigate the plant's status prior to the recent election, recommended unanimously against the sale of the plant.

N.A.S.E. Convention Committees

Front Row, Left to Right: J. P. Buller, H. R. Hilton, F. J. Fischer, John Topham, and H. G. Smoth. Second Row: C. T. Bailie, O. D. Spray, T. R. Harlihy, H. G. Knapp, B. C. Parker, and T. S. Simpson. Rear Row: W. D. Campbell, L. C. Brown, and W. T. W. Curl

Col. Henry G. Prout, Engineer, Editor, Soldier, Dies

Funeral services were held at Calvary Church, Summit, N. J., Jan. 29 for Colonel Henry G. Prout, civil engineer and Civil War veteran, who died, Jan. 27, at his home. He was eighty-two years old.

Colonel Prout was born in Virginia in 1845. During the Civil War he sreved with the 57th Massachusetts Volunteers. He served under General Barlow on the first government survey which determined the boundaries of Yellowstone Park.

His survey work brought him to the attention of General Sherman, and he was one of six young men who, at the request of the Khedive of Egypt, were recommended by General Sherman for military service there. He went to Egypt as major of engineers. He served with distinction under General Charles Gordon, whom he succeeded as Governor General of the Provinces of the Equator.

After four years in Africa Colonel Prout returned to America. He was for sixteen years editor of *The Railroad Gazette*, now *The Railway Age Gazette*, and was a prominent figure in the railway and engineering world. Following his retirement from this magazine he was connected for twelve years with the Westinghouse interests at Pittsburgh.

A.S.M.E. Research Committee Undertakes New Projects

At its recent meeting in Washington, D. C., the Council of the A.S.M.E. authorized the main Research Committee of the society to undertake several new projects. Of interest to power engineers are, among these, "The Strength of Cylindrical Vessels Under Pressure" and the "Absorption of Radiant Heat in Boiler Furnaces."

The first of these was suggested by the Boiler Code Committee and has as its purpose the determination of methods of computation for strength of cylindrical surfaces under pressure, with particular reference to jacketed cylinders.

Originating with individual members of the society, a careful study of the subject of radiant heat in boiler furnaces will be made with the object of recommendations for improved furnace designs.

Unit for Oklahoma Plant of Public Service Company

The Public Service Company of Oklahoma has started construction on the first 15,000-kw. unit for a new power plant located at Weleetka, Okla. The plant, when finally completed, will include three such units, making it the largest electrical generating station yet proposed for Oklahoma.

Correction: In the Jan. 25 issue of *Power*, page 147, the names of Samuel Insull and Dr. M. I. Pupin, as trustees of the National Museum of Engineering and Industry, were inadvertently omitted; and that of George E. Roberts, not at present a trustee, included.

Colorado Steel Plant Equips With Electric Drive

What is reported the largest steel plant in the West, that of the Colorado Fuel & Iron Co. at Pueblo, Colo., has now started operation with its new electrical equipment. This company recently made a complete change-over from steam to electric drive with the exception of its blooming mills, using electricity generated on the premises in the largest industrial plant in the Rocky Mountain region.

All the main electrical equipment, including the turbine-generators in the power house, was furnished by the General Electric Co. Among the items are three 10,000-kw. turbine-generators to furnish power for the various mills, and two 1,000-kw. motor-generators to furnish direct current to the power house and the adjacent mills.

The company, incorporated in 1892, until a few years ago used steam engines to derive all power for the plant. Electrification was first considered during the period following the War, and the initial program included a power plant, the electrification of the rod and 10-in. mill, the 10-in. mill and the rail mill.

Tells of East River Station Before Electrical League

At a joint luncheon meeting of the New York Electrical League and the Electrical Board of Trade at the Hotel Astor, New York, last Thursday, John W. Lieb, vice-president and general manager of the New York Edison Company, gave an illustrated lecture on the New East River Station of that company.

He traced the growth of the Edison System in New York from the old Pearl Street Station erected in 1882 to the New East River Station, designed for a capacity approximately one thousand times that of the original station. The growth in system load over this period has averaged approximately 12 per cent per year.

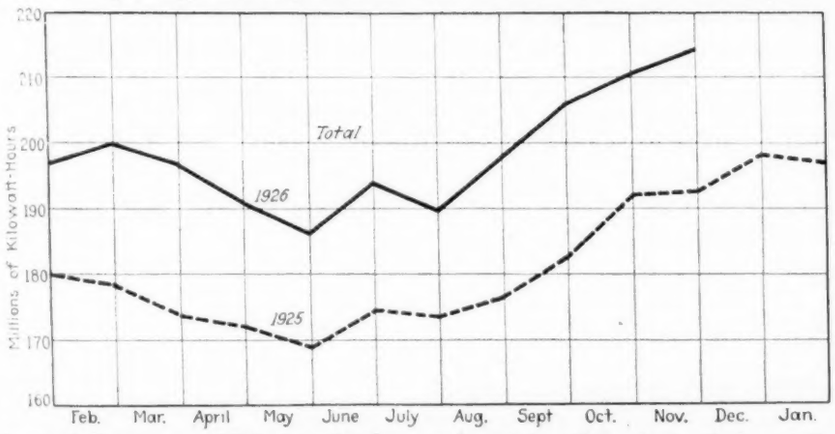
November Electrical Output Exceeded All Monthly Records for 1926

ACCORDING to the report compiled by the Division of Power Resources of the Geological Survey, Department of the Interior, on the production of electrical power by public-utility plants in the United States for the period of September, October and November of last year, the average daily production for November exceeded all previous daily rates, with an output of 214,900 kw.-hr. per day, exceeding the maximum daily rate established in October by about 1½ per cent.

Based on the records of all eleven months covered in the report, the total output of electricity in 1926 is estimated to be about 73,300,000,000 kw.-hr.

Production by the use of fuels for these months totaled 12,721,292 thousands, and by water power 6,458,428 thousands, thus showing a percentage of the whole of 66.3 for fuel generation and 33.7 for water.

The quantities given in the tables are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, electric railway plants and certain other plants that contribute to the public supply. Reports are received from plants representing over 95 per cent of the total capacity. The output of those plants which do not submit reports is estimated to as close an approximation as possible.



Boiler Manufacturers Plan Cleveland Meeting

At the winter meeting of the American Boiler Manufacturers Association, which is scheduled to take place at the Hotel Cleveland, Cleveland, Ohio, the morning of Feb. 11, a number of important reports and addresses will be made.

The reports include that of the national trade survey of the boiler industry, one on the oil field boiler industry, a report on steel heating boilers and a report on the power test code.

Mortimer B. Lane, of the United States Department of Commerce, will make an address, according to announcement. Other important miscellaneous business will be taken up. By notifying A. C. Baker, secretary of the association, at 801 Rockefeller Bldg., Cleveland, Ohio, or the Hotel Cleveland directly, accommomations may be secured.

Public Committee on Power Backs Smith's Program

A group functioning as the Public Committee on Power, with the object of furthering Governor Smith's program for a water power authority, formed a permanent organization Jan. 21 in New York, electing Arthur Garfield Hays as chairman.

Before the formal organization was put through, Colonel F. S. Greene, superintendent of Public Works, explained the water-power situation in the state to the meeting. He stressed the need of State control of water power, told of the "unfortunate experiences New York State had had with private interests," and asserted that by owning and controlling its water power facilities the state can develop an income of more than $37,000,000 a year, or enough to permit the abolition of the state income tax.

After Colonel Greene had spoken, Stephen Raushenbush, secretary of the committee, asserted that the control of water power was more than ever necessary, because the Public Service Commission now performs its task merely in a formal way, so that the regulatory system of the state is largely ineffective, especially as to rate fixing.

Army Engineers for Power Detail, Bill Suggests

Authority for the President to detail officers in the Engineer Corps of the Army and other branches of the service, to serve the Federal Power Commission, is proposed in a bill introduced by Representative Parker (Republican), of Salem, N. Y.

TOTAL PRODUCTION OF ELECTRIC POWER BY PUBLIC UTILITY PLANTS, SEPTEMBER, OCTOBER, NOVEMBER, 1926, IN THOUSANDS OF KILOWATT-HOURS

	Water Power			Fuels			Total 1926		
U. S. and Divisions	September	October	November	September	October	November	September	October	November
United States	2,058,090	2,159,334	2,241,004	4,122,102	4,394,257	4,204,933	6,180,192	6,553,591	6,445,937
New England	87,204	119,650	166,945	335,991	337,473	286,307	423,195	457,123	453,252
Middle Atlantic	467,174	535,607	548,333	1,181,213	1,275,865	1,264,610	1,649,387	1,811,472	1,812,943
East North Central	171,005	195,143	199,054	1,334,007	1,406,146	1,343,472	1,505,012	1,601,289	1,542,526
West North Central	145,987	154,874	143,373	247,606	251,051	256,462	393,593	405,925	399,835
South Atlantic	156,554	150,607	165,226	450,649	475,355	487,115	607,203	625,962	652,341
East South Central	162,537	136,555	178,307	105,109	163,467	97,119	267,646	300,022	275,426
West South Central	1,454	3,499	6,338	222,496	230,595	223,035	223,950	234,094	229,373
Mountain	245,499	235,550	231,678	51,269	56,204	58,202	296,768	291,754	289,880
Pacific	620,676	627,849	601,750	192,762	198,101	188,611	813,438	825,950	790,361

Obituary

Arthur Williams Pearce, treasurer of the Williams-Harvey Corp., 111 Broadway, New York, died Jan. 24 at his residence, 277 Park Avenue, after a ten days' illness.

Mr. Pearce had been with the Williams-Harvey Corp. since its organization in 1917. He was a son of Richard Pearce, a pioneer in the tin smelting industry in this country. He graduated from Yale in 1896.

Rudolf E. Bujarski, mechanical engineer for seven years with the Forstmann & Huffmann Co., Passaic, N. J., as superintendent of the engineering department of the company's textile mills, died at his home in Passaic Jan. 21. Mr. Bujarski was born in Stettin, Germany, April 24, 1888. He gained his early education and engineering training in that country. Before his association with the Forstmann & Huffmann Co. he was connected with the Jamaica plant of the Curtiss Aeroplane & Motor Corporation.

Anson Wood Burchard, vice-chairman of the board of directors and chairman of the executive committee of the General Electric Co., and chairman of the board of directors of the International General Electric Co., died in New York City, Jan. 22. Funeral services were held from his late home, 690 Park Avenue, New York, Jan. 25. Burial was at Locust Valley, L. I. Graduated from Stevens Institute of Technology in 1885 with the degree of mechanical engineer, Mr. Burchard in 1902 joined the organization of the General Electric Co., and until 1904 held the post of comptroller, with headquarters at Schenectady. In 1904 he was named assistant to the president, in 1912 he was elected a vice-president, and in 1917 was elected a member of the board of directors. In May, 1922, he was elected vice-chairman of the board, and in June of the same year he was elected president and chairman of the board of directors of the International General Electric Co.

Personal Mention

Charles M. Schwab, president of the American Society of Mechanical Engineers, sailed for a vacation in Europe Jan. 29.

Henry E. Aldrich has been promoted by the Wickes Boiler Co. to the position of general manager, with headquarters at Saginay, Mich.

Martin T. Hooper, consulting engineer, has moved his offices from the I. W. Hellman Building, Los Angeles, Calif. to the Heating and Ventilating Building of the same city.

Thomas Eyre, formerly dean of engineering of the University of New Mexico, has been appointed professor of mechanical engineering of the University of Southern California.

William De Baufre, formerly chairman of the mechanical engineering department of the University of Nebraska, is now on leave of absence and is acting as technical advisor to the International Combustion Engineering Corporation of New York.

Coming Conventions

American Boiler Manufacturers Association will hold meeting at Hotel Cleveland, Cleveland, Ohio, Feb. 11; A. C. Baker, secretary and treasurer, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting which was held at Montreal on Thursday, Jan. 27, was adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

Michigan Engineering Conference at Hotel Statler, Detroit, Mich., Feb. 3 and 4. E. L. Brandt, secretary.

Midwest Power Conference, at Chicago, Feb. 15-18. Sessions will be held in the Coliseum concurrently with the Chicago Power Show; G. E. Pfisterer, secretary.

National Association of Stationary Engineers—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., during second week of June.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Marine Engineers' Beneficial Association. Fifty-second annual convention at the Hotel Franklin Square, Washington, D. C., Feb. 14-19. Albert L. Jones, secretary-treasurer.

Henri A. Sevigne, a member of the Boston Section of the A.S.M.E., has been elected a life fellow of the Royal Society of Arts, London, Eng.

Harry E. Miller has been advanced to the position of works manager of the Newark plant of the Westinghouse Electric and Manufacturing Co. after serving several years as assistant works manager. He has been with the company thirty-seven years, rising through the various departments.

Dr. John B. Whitehead, professor of electrical engineering and dean of the School of Engineering at Johns Hopkins University in Baltimore, has been appointed exchange professor to France, where he will represent as international exchange professor in engineering and applied science not only his own university, but Harvard, Yale, Columbia, Cornell, Pennsylvania and the Massachusetts Institute of Technology as well. His tentative program abroad includes a tour of seven of the leading universities of France, where he will give a series of lectures on dielectric theory and insulation.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Jan. 24 1927
Pool 1	New York	$3.00@$3.50
Smokeless	Boston	2.50
Clearfield	Boston	2.25@ 2.65
Somerset	Boston	2.35@ 2.80
Kanawha	Columbus	1 75@ 2.00
Hocking	Columbus	1 75@ 2.00
Pittsburgh	Pittsburgh	1 90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Frankfin, Ill.	Chicago	2 50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2 25@ 2.50
West Ky.	Louisville	1 25@ 1.60
S. E. Ky.	Louisville	1 75@ 2.00
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 5.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.25
Birdseye	New York	2.00

FUEL OIL

New York—Jan. 27, light oil, tank-car lots; 28@34 deg. Baumé, 5⅜c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Jan. 19, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.02½ per bbl.; 26@28 deg., $2.07½ per bbl.; 28@30 deg., $2.12½ per bbl.; 30@32 deg., $2.17½ per bbl.; 32@36 deg., gas oil, 5.926c. per gal; 38@40 deg., 6.801c. per gal.

Pittsburgh—Jan. 18, f.o.b. local refinery; 30@34 deg., fuel oil, 6⅜c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Philadelphia—Jan. 19, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.725@$1.785 per bbl.

Cincinnati—Jan. 25, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Jan. 25, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.65.

Boston—Jan. 24, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.5c. per gal.; 28@32 deg., 5¾c. per gal.

Dallas—Jan. 25, f.o.b. local refinery, 26@30 deg., $1.73 per bbl.

Business Notes

The Merco Nordstrom Valve Co., subsidiary of the Merrill Co., San Francisco, Calif., manufacturing and distributing the Merco Nordstrom plug valve, has leased a modern factory building at Twenty-fourth and Oeralta streets, Oakland, Calif. The new plant will be ready for operation in the late spring or early summer.

The Botfield Refractories Co., Philadelphia, Pa., reports the recent appointment of the Southern Steel & Cement Co., Asheville, N. C., Henry A. Petter Supply Co., Paducah, Ky., Columbia Supply Co., Columbia, S. C. and the Spartanburg Mill Supply Co., Spartanburg, S. C., for the distribution of Adamant firebrick cement.

The Oil City Boiler Works, Oil City, Pa., have reported the following directors and officers elected at the annual meeting: President, Frank O'Day; vice-president and general manager, William H. Heagerty; secretary and treasurer, F. M. Baldwin. Directors: E. C. Breene, president First National Bank; Frederick Fair, president Oil City Trust Co.; Frank O'Day, William Heagerty and Daniel O'Day, all of Oil City, and L. C. Frohrieb, president Federal Engineering Co., Pittsburgh, Pa. and Van A. Reed, Jr., Pittsburgh, Pa.

Louis B. Seidman, attorney-engineer, announces that he is now engaged in the special practice of engineering law at 1440 Broadway, New York City.

The R. H. Baker Co., Cambridge, Mass., announces the opening of a district office in the General Motors Building, Detroit, Mich. This company specializes in high-pressure power plant and industrial piping installations.

The Laclede-Christy Clay Products Co., St. Louis, Mo., in the firebrick business for the last 83 years, was given tribute as the first refractories company to establish a research laboratory, "when twenty-five years ago, James Green, its founder, saw need to bring research rooms out of the garret," in the Jan. 2 issue of the *St. Louis Globe-Democrat*. The progress of the company, its achievements under great difficulties and its present prestige are outlined in an article of considerable length.

Trade Catalogs

Water Tube Boilers—The Southwestern Engineering Corp., consulting engineers and manufacturers, Los Angeles, Calif., have issued catalog B on Collins water tube boilers.

Arc Welding Accessories—The General Electric Co. in bulletin GEA-571 calls attention to the hand shield and helmet manufactured by the company for safety in arc welding.

Centrifugal Pumps for Oil and Gasoline—The Wilson-Snyder Manufacturing Co., Pittsburgh, Pa., in a recent bulletin deals with centrifugal pumps designed for gasoline and all grades of oil.

Mechanical Drive Turbines — The General Electric Co. describes mechanical drive turbines of type D in an illustrated bulletin which gives construction details of type-54 turbine opened for inspection. The construction of types D-52 and D-53 mechanical-drive turbines is also outlined and illustrated.

Steam Turbine Generators — The American Brown Boveri Electric Corp. has recently issued its descriptive circular No. 100, on steam turbine-generators. This is an attractive booklet of 48 pages, letter size, describing the turbines and the turbine design practice of the company, with details of a number of distinctive features of construction. The illustrations show both mechanical and electrical details, as well as a large number of installations and applications.

New Plant Construction

Calif., Colusa—Union Ice Co., 354 Pine St., San Francisco, is receiving bids for the construction of an ice plant at Main and 11th Sts., here. Estimated cost $40,000. Private plans. Equipment will be required.

Calif., Coronado—Island City Hotel Co., c/o Kibbey & Bates, 660 South Vermont St., Los Angeles, Archts., is having plans prepared for the construction of a 6 story hotel including steam heating and refrigeration systems, elevators, etc. Estimated cost $750,000.

Calif., Santa Barbara—A. L. Richmond, c/o J. M. Cooper, Rives-Strong Bldg., Los Angeles, Archt., is having plans prepared for the construction of a 6 story hotel including steam heating and refrigeration systems, electric elevators, etc.

Calif., Santa Monica—Miramar Hotel Co. awarded contract for the construction of a 10 story hotel to Scofield Engineering & Construction Co., Pacific Finance Bldg., Los Angeles. Estimated cost $750,000. Steam heating plant, electric elevators, etc., will be installed.

Calif., Turlock—Turlock & Modesto Irrigation Dists., A. Sorenson, Secy., awarded contracts for construction of Don Pedro power plant addition and installation of two power units on Tuolumne River, Tuolumne County.

Conn., Bridgeport — United Illuminating Co., 1115 Broad St., awarded contract for the construction of a hydro-electric plant on East Main St., to Foundation Co., 120 Liberty St., New York, N. Y. Estimated cost $700,000.

Conn., Mansfield — State of Connecticut awarded contract for the construction of two buildings in connection with pumping station to Dennis O'Brien & Sons Co., 118 Asylum St., Hartford. Estimated cost $75,000.

Conn., Norwich—Standard Oil Co., 26 Broadway, New York, N. Y., is having plans prepared for the construction of a pump house, etc., on Rhames River. Private plans.

Fla., Cedar Key—Bd. of Bond Trustees will soon award contract for improvements to waterworks and sewage systems including wells, pumping station, pumps, reservoir, etc. Total estimated cost $105,000. Main Engineering Co. is engineer.

Ill., Chicago—V. J. Curto, 4615 Broadway, is having sketches made for the construction of a 20 story office and stores building at Lawrence Ave. and Broadway. Estimated cost $3,500,000. Huzagh & Hill, 6 North Michigan Ave., are architects.

Ill., Chicago—Hall, Lawrence, Rippel & Ratcliffe, 123 West Madison St., Archts., is receiving bids for the construction of a 14 story hotel at Stony Island Ave. and Marquette Rd. for Calumet Council, Knights of Columbus. Estimated cost $2,000,000.

Ill., Chicago — H. Dalsey, 64 West Randolph St., Archt., is receiving bids for the construction of a 12 story apartment including elevators at 11-13 West Division St., for M. K. Wolf. Estimated cost $500,000.

Ill., Chicago — Municipal Tuberculosis Sanitorium, 2049 West Washington Blvd., awarded contract for the construction of a hospital at Bryn Mawr and Crawford Aves. to R. C. Weiboldt & Co., 1534 West Van Buren St. Estimated cost $600,000. Steam heating system, elevators, etc., will be installed.

Ill., Chicago—Syndicate, Fox & Fox, 38 South Dearborn St., Archts., had plans prepared for the construction of a florists building including refrigeration system, elevators, etc. at Randolph and Elizabeth Sts. Estimated cost $1,000,000.

Ill., Chicago—H. Zisook, 1209 East 55th St., will soon receive bids for the construction of a 10 story apartment including refrigeration system, elevators, etc., at 5719 Kenwood Ave. Estimated cost $800,000. T. R. Bishop & Son, 35 South Dearborn St., are architects.

Ky., Augusta—City had plans prepared for the construction of a waterworks system including reservoir, pumps, motors, etc. Estimated cost $38,000. Cole, Asire & Moore, 730 J. M. S. Bldg., South Bend, Ind., are engineers.

Ky., Princeton—City had plans prepared for the construction of a waterworks system including pump, tank on tower, etc. Black & Veatch, 709 Mutual Bldg., Kansas City, Mo., are engineers.

La., Jackson—D. Stewart & Associates, Natchez, Miss., is having revised plans prepared for the construction of a waterworks and distribution system and electric power plant including a 200 kw. unit here. Estimated cost $400,000.

Md., Baltimore—Crosse & Blackwell, c/o Clark, MacMullen & Riley, 101 Park Ave., New York, N. Y., Engrs., will receive bids until Feb. 1 for the construction of a plant including power house at Eastern Ave. and 42nd St. here. Estimated cost $100,000.

Md., Frederick—Hood College, will soon award contract for the construction of a boiler house, etc. J. B. Hamme, 31 West Market St., York, Pa., is architect.

Md., Hagerstown—Bd. of Street Comrs., will receive bids until Feb. 1 for the construction of an electric light plant. L. T. Klauder, Bankers Trust Bldg., Philadelphia, Pa., is consulting engineer.

Mass., Cambridge (Boston P. O.)—H. F. Stimson, 10 Temple St., is receiving bids for the construction of a boiler house and two warehouses. Monks & Johnson, 99 Chauncy St., Boston, are engineers.

Mich., Ann Arbor—M. H. Finkel, 1333 Book Bldg., Detroit, Archt., is preparing plans for the construction of a 9 story hotel including steam heating boiler and equipment, elevators, etc. on Fourth St. Estimated cost $1,200,000. Owner's name withheld.

Mich., Detroit—United Artists' Corp. and Detroit Properties Corp., 810 Bagley Ave., is having plans prepared for the construction of an 18 story theatre and office building including steam heating system, elevator, etc. Estimated cost $6,000,000. C. H. Crane, 542 Griswold St., is architect.

Miss., Aberdeen—Aberdeen Creamery Co., F. Johnson, Pres., awarded contract for the construction of a creamery and cold storage plant to Brannon Construction Co.

Mo., Carthage—City is having plans prepared for the construction of a power plant including Diesel engine, etc. Estimated cost $50,000. E. S. Glenn, City Hall, are engineers.

Mo., St. Louis—William Fox Film Co., 55th St. and 10th Ave., New York, N. Y., awarded general contract for the construction of a 17 story theatre and office building on Grand St. here, to Aronberg & Fried Inc., 21 East 40th St., New York, N. Y. Estimated cost $3,250,000.

Neb., Brainard—City plans an election soon to vote $20,000 bonds for waterworks improvements including wells, pumping equipment, tank on tower, etc. Grant, Fulton & Letton, 525 South 13th St., Lincoln, are engineers.

Neb., Falls City—Nebraska Ice & Cold Storage Co., will build addition to ice plant by day labor. Estimated cost $50,000.

Neb., Grand Island—City, H. E. Clifford, Clk., will receive bids about Feb. 15 for improvements to electric light and power plant including additional power buildings, etc. Estimated cost $50,000. Pillsbury Engineering Co., 2344 Nicollet Ave., Minneapolis, Minn., is engineer. Contracts for turbines and condensers have been awarded.

N. J., Atlantic City — Bd. of Comrs. awarded contract for the construction of a convention hall including ice skating rink, to M. B. Markland Co., 3540 Atlantic Ave. Steam heating system, elevators, etc., will be installed.

N. J., Elizabeth—One Thousand Fifty-Five East Jersey St. Corp., 190 Market St., Newark, awarded contract for the construction of a hotel, to A. G. Construction Co., 190 Market St. Estimated cost $500,000. Steam heating system, elevators, etc. will be installed.

N. Y., East Chester (mail Greycourt)—Searsdale Corp., R. Navas, Secy., 500 5th Ave., New York, is having plans prepared for the construction of a 6 story apartment including steam heating system on Belamy Rd. here. Estimated cost $500,000. E. D. Letchfield, 578 5th Ave., New York, is architect.

N. Y., New York—Eight Hundred Twelve Park Ave. Corp., c/o J. E. R. Carpenter, 598 Madison Ave., Archt., is having plans prepared for the construction of a 14 story apartment including steam heating system, 3 elevators, etc. at 46 East 75th St. Estimated cost $1,140,000.

N. Y., New York—Fifty One West Sixty-Sixth St. Corp., M. Seigel, Pres., 120 Broadway, awarded contract for the construction of a 16 story apartment on West 86th St., to J. E. Seigel, 345 Madison Ave. Estimated cost $800,000. Steam heating system, elevators, etc. will be installed.

N. Y., New York—H. Lee, c/o Moore & Landseidel, 148th St. and Third Ave., archt., is having plans prepared for the construction of a 15 story apartment on Pelham Parkway. Estimated cost $2,500,000.

N. Y., New York—Nine Hundred Seventy One Madison Ave. Corp., c/o M. L. Freehoff, 415 Lexington Ave., Archt., is having plans prepared for the construction of a 14 story medical building including steam heating system, elevators, etc. Estimated cost $1,000,000.

N. Y., New York—Sammin Holding Corp., S. Minskoff, c/o E. Roth, 1440 Broadway, will build a 12 story apartment including steam heating system, 3 elevators, etc. at Madison Ave. and 87th St. Estimated cost $2,000,000. Work will be done by separate contracts.

N. Y., New York—Western Union Telegraph Co., 195 Broadway, plans the construction of an office building including steam heating system, elevators, etc. on West Broadway. Estimated cost $500,000. Private plans.

N. Y., New York—S. Winck, 2061 Broadway, plans the construction of a 6 story apartment including steam heating system, 2 elevators, etc. at Anderson Ave. and 166th St. Estimated cost $750,000. Architect not selected.

O., Cleveland—Cleveland Electric Illuminating Co., Illuminating Bldg., awarded contract for remodeling factory and boiler house at 3601 Ridge Rd. to Sam W. Emerson Co., 1836 Euclid Ave. Estimated cost $50,000.

O., Cleveland—The Fisher Body Ohio Co., Cort Rd., awarded contract for the construction of addition to boiler house to Hunkin-Conkey Construction Co., Hunkin-Conkey Bldg. Estimated cost $40,000.

Okla., Maud—City plans an election Feb. 15 to vote $15,000 bonds for waterworks improvements including well, deep well pump and motor, etc. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Okla., Ponca City—City has acquired a site and plans the construction of a power plant. Estimated cost $300,000.

Okla., Ponca City—Ponca City Milling Co., will soon receive bids for the construction of a 6 story mill including boiler and engine room, etc. Horner, Wyatt & Roads, 468 Bd. of Trade Bldg., Kansas City, Mo., are engineers.

Tex., Fayetteville—City is receiving bids for waterworks improvements including well, pumping plant, pump, 50,000 gal. tank on tower, etc. Estimated cost $30,000.

Tex., Henderson—East Texas Public Utilities Corp., 72 West Adams St., Chicago, Ill., has acquired the plant of the Henderson Light & Ice Co., and is having surveys made for extensions and improvements here. Private plans. New machinery will be required.

Tex., Houston—H. Roberts & G. W. Gigyshall, 321 Thompson St., San Antonio, has acquired a site and plans the construction of a 40 ton ice plant here. Estimated cost 75,000. Architect and engineer not selected.

Tex., Luling — Central Power & Light Co., E. B. Neiswanger, Frost Bldg., San Antonio, has acquired a site and plans the construction of a 30 ton ice plant to replace present one here. Estimated cost $40,000. Private plans. Machinery, probably electrically driven will be required.

Tex., Perryton—Inland Utilities Co., Kansas City, Mo., is having plans prepared for extensions and improvements to electric light plant here. Private plans. New machinery will be required.

Wis., Madison—Balch & Lippert, Gay Bldg., Archts., are preparing plans for the construction of a 9 story office building including steam heating system. Estimated cost $600,000. Owner's name withheld.

Mexico, Nueva Laredo—Laredo Downs Inc., c/o J. W Choate, R. E. Lee Hotel, Laredo, awarded contract for the construction of an 8 story hotel here to Kelwood Co., Travis Bldg., San Antonio, Tex. Estimated cost $750,000. Heating plant, refrigeration system, 5 elevators, etc. will be installed.

Equipment Wanted

Ky., Augusta—City is in the market for reservoir, pumps and motors, for proposed waterworks system.

Mass., Boston—Bureau of Supplies & Accounts, Navy Dept., Washington, D. C., will receive bids until Feb. 2 for transformers etc. at Navy Yard, here.

Miss., Utica—City will receive bids until Feb. 1 for one 120 hp. Diesel engine direct connected to alternator with exciter and auxiliaries.

Mo., Chillicothe—Bd. of Public Works will receive bids until Feb. 15 for furnishing and installing a 1,500 kw. turbine and generator.

O., Beachwood (Cleveland P. O.)—Village is having plans prepared for the construction of a booster pumping station, 100 ft. high, including 1,000,000 gal. pump. C. W. Courtney, 1770 East 11th St., is engineer.

O., Cleveland—A. Angel, 2077 East 4th St., is in the market for a small d.c. electric motor.

O., Toledo—City, W. B. Guitteau, Dir. of Public Service, will receive bids until Feb. 1 for the construction and installation of a 30,000,000 g.p.d. steam turbine driven centrifugal high service pumping unit for Broadway pumping station.

Okla., Weleetka—The L. E. Myers Co., prices and catalogs on reinforcing steel chains and pulsometer or sand pumps.

Pa., Oil City—City, B. B. Weber, City Engr., City Hall, will receive bids until Feb. 14, for one 1,500,000 g.p.d. vertical triple expansion, condensing, crank and fly-wheel pumping engine against a head of 300 lbs.

Tenn., Nashville—City will receive bids until Feb. 1 for two 2,000,000 gal. centrifugal pumps, also electric transformers, etc.

Va., Fredericksburg — Common Council, L. J. Houston, Jr., Mgr., will receive bids until Feb. 17 for the construction of a 2,000,000 g.p.d. rapid sand filter plant, also the installation of centrifugal pumps and motors, etc. Fuller & McClintock, 170 Broadway, New York, N. Y., are consulting engineers.

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